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THE ECONOMIC DISTURBANCES SINCE 1873.

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V.

IN the preceding paper of this series (No. IV), evidence was submitted to the effect that the remarkable decline in prices which has occurred during the last ten or fifteen years—or since 1873—in the case of the various commodities which constitute the great bulk of the trade, commerce, and consumption of the world, has been so largely due to conditions affecting their supply and demand that, if any or all other causes whatever have contributed to such a result, the influence exerted has not been appreciable; and, further, that if the prices of all other commodities, not included in such analysis, had confessedly been influenced by a scarcity of gold, the claims preferred by the advocates of the latter theory could not be fairly entitled to any more favorable verdict than that of "not proven." But have commodities, other than those whose production and price-experience have been submitted—more especially such commodities as have not in recent years experienced any marked change in their conditions of supply and demand—exhibited in their recent price-movements any evidence of having been subjected to any influences attributable to the scarcity of gold? The answer is, that not only can no results capable of any such generalization be affirmed, but no one commodity can even be named, in respect to which there is conclusive evidence that its price has been affected in recent years by influences directly or mainly attributable to any scarcity of gold for the purpose of effecting exchanges.

In the first place, all that large class of products or services, which are exclusively or largely the result of handicrafts; which are not capable of rapid multiplication, or of increased economy in production, and which can not be made the subject of international competition,

have exhibited no tendency to decline in price, but rather the reverse. A given amount of gold does not now buy more, but less, of domestic service and of manual and professional labor generally than formerly; does not buy more of amusements; not more of hand-woven lace, of cigars, and of flax, which are mainly the products of hand-labor; of cut-glass, of gloves, of pictures, or of precious stones. It buys notably less of hides and leather, which are the sequences of cattle-growing, which in turn involves time, and for which, in point of economy, large sections of the earth are not adapted; of horses, and most other animals; of pepper; of cocoa, the cheap production of which is limited to a few countries, and requires an interval of five years between the inception and maturing of a crop; of malt liquors, eggs, currants, and potatoes; and also of house-rents, which depend largely upon the price of land, and which in turn is influenced by fashion, population, trade, facilities for access, and the like.

How little of change in price has come to the commodities of countries of low or stagnant civilization, that have remained outside of the current of recent progress, is strikingly illustrated in the case of a not unimportant article of commerce, namely, the root *sarsaparilla;* which, with a gradually-increasing demand, continues to be produced (collected and prepared) in Central America, by the most primitive methods, and, without any change in the conditions of supply, save, possibly, some greater facilities for transportation from the localities of production to the ports of exportation. Thus, in the case of Honduras sarsaparilla, at New York, which is the principal distributing market of the world, the average price for the best grade is reported as identical for the years 1881 and 1886; while for the "Mexican," the average reported for 1881 was eight cents per pound, and for 1886, with much larger sales, from seven to eight and a quarter cents.

All the evidence, furthermore, tends to show that there has been very little decline in recent years in the prices of such of the commodities of India as constitute her staple exports, which can not, as will be hereafter shown, be clearly referred to agencies entirely disconnected with any influence assumed to have been occasioned by any increase in the purchasing power of gold due to its absolute or relative scarcity.*

Now, all of the commodities referred to, including labor and personal service, and many others which might be specified, whose condition in recent years has not been materially influenced by changes

* According to Mr. Robert Giffin, in his testimony before the British Commission, "On the Changes in the Relative Values of the Precious Metals," 1886, the general result of a comparison of India prices submitted to the Commission "On Trade Depression," shows a fall of only two per cent in 1880–'84, as compared with 1870–'74, or with the period immediately before the fall in silver:

"The general conclusion appears to me to be that the effect of the present relations between gold and silver have not told appreciably on prices in India, or on the relative progress of her import and export trade."—*Testimony of Sir* LOUIS MALLET, *late Under-Secretary of State for India, Trade Depression Commission*, 1886.

affecting their supply and demand, ought to have exhibited evidence, in a decline of prices, of the influence of the scarcity of gold, if any such had been exerted; but they not only do not, but the drift of the evidence deducible from their price-experiences is rather in favor of the position recently taken by some economists, that gold in recent years, in place of becoming scarce for purposes of exchange, has really been more abundant.

The record of extreme changes in prices by reason of circumstances that are acknowledged to have been purely exceptional, is also most instructive, and removes not a few commodities from the domain of any controverted economic theory respecting monetary influences. Thus, from 1862 to 1870, cotton, owing to war influences, ruled so high—from 70 to 800 per cent in excess of normal prices—that its inclusion in computations, with a view of determining any average of prices, or generalization of causes affecting prices during the years mentioned, would, without proper allowance, completely vitiate any conclusions.

War and interruption of traffic on the Upper Nile have increased the prices of "gum-Arabic," and of the drug "senna" in recent years more than 100 per cent. The prices for French and other competing light wines and brandies are much higher than the average for 1866–'67, because the phylloxera has so impaired the production of French vineyards that France now imports more wines than she exports. "Cochineal" and "madder" have greatly declined in price since 1873, because their use as dye-stuffs has been to a great extent superseded by equivalent and cheaper coloring-materials derived from coal-tar; and within a very recent period the discovery of a method of cheaply preparing a chemical preparation from cloves, having all the flavoring qualities of the vanilla-bean, has already diminished the demand, and bids fair to greatly impair the price of this heretofore scarce and costly tropical product. Certain animal products, notably entering into commerce, have rapidly advanced in price in recent years by reason of a rapid diminution in the number of the animals affording them, as buffalo-horns, ivory, and whalebone, which latter product has increased in price from 32½ cents per pound in 1850 to 85 cents in 1870, and $3.50 in 1886.

An agency which has been most influential in recent years, in occasioning a decline in the price of commodities, which has acted universally, which is entirely the outcome of new processes, construction, and machinery, and has no connection whatever with matters pertaining to currency or standards of value, has been the reduction in the cost of transportation or distribution. Its influence has also necessarily manifested itself very unequally, occasioning the greatest price-reductions in the case of articles—like cereals, meats, fibers, ores, and all coarser materials—in respect to which transportation constitutes the largest element of cost at the place of consumption; and least in the

case of articles—like textiles, spirits, spices, teas, books, and similar products—where great values are comprised in small bulk. The investigations of Mr. Atkinson show that, had the actual quantity of merchandise moved by the railroads of the United States in 1880 been subjected to the average rate per ton per mile which was charged from 1866 to 1869, the difference would have amounted to at least $500,000,000 (£100,000,000), and perhaps $800,000,000 (£160,000,000), more than the actual charge of 1880. Comparing 1865 with 1885, Mr. Atkinson further shows that, taking a given weight of goods to be moved from Chicago to New York, one thousand miles, by the New York Central Railroad, 58 per cent of the original value was absorbed in transportation and depreciation of the currency in the former year; while in 1885 only 20 per cent was so absorbed—the charge per ton per mile having fallen from 3·45 cents in 1865 to ·68 of a cent in 1885.

The fall in price for the carriage of commodities by sea has also been as remarkable as the decline in the cost of carriage by land. Freight, on the average, between Calcutta and England had experienced a decline of about 50 per cent in 1885 as compared with 1875. In the case of India wheat transported to England *via* the Suez Canal, the decline in freights was from 71*s.* 3*d.* per ton in October, 1881, to 27*s.* in October, 1885, or more than 63 per cent. Between 1873 and 1885 the tolls and pilotage on the Suez Canal were reduced to the extent of about 33 per cent.

Freights from New York to Liverpool declined, from 1880 to 1886, as follows (maximum and minimum): On grain, from 9½*d.* to 1*d.* per bushel; on flour, from 25*s.* to 7*s.* 6*d.* per ton; on cheese, from 50*s.* to 15*s.* per ton; on cotton, from ⅝*d.* to $\frac{7}{16}$*d.* per pound; and on bacon and lard, from 45*s.* to 7*s.* 6*d* per ton. Subsequently, prices recovered somewhat, but by no means to the extent of the rates current in 1880 and preceding years.

It is not, however, to be concealed that numerous economists and statisticians of high repute—Mr. Sauerbeck and others—are nevertheless of the opinion that, allowing all that has been claimed for the influence on prices occasioned by reduction of cost through increased and cheapened production and distribution, the decline in recent years is too great to be "simply explained away" by these agencies. But these authorities have specified no commodities, the analysis of whose production and price-experiences in recent years furnish any sufficient foundation for such a general conclusion; and it is interesting to note how the experiences of the few, which at first thought would seem to indicate the sensible influence of "other" agencies, on analysis prove to the contrary. Thus, in the case of wool, Messrs. Helmuth, Swartze & Co., of London, the best recognized authorities on this commodity, in their annual circular for 1887, after admitting the great increase in the production of wool in the years from 1860 to

1886, nevertheless claim that consumption has at the same time increased to such an extent, that the general assumption of an excessive production of this commodity has not been warranted, and in truth has "but slightly exceeded the ordinary growth of population, and that, therefore, other influences must have been at work to cause the great decline in its price which has characterized the course of events during recent years." But to this it may be replied, that when the supply of any commodity exceeds by even a very small percentage what is required to meet every demand for current consumption—specially in the case of a staple commodity like wool, whose every variation in supply and demand is studied every day, as it were microscopically, by thousands of interested dealers and consumers—it is the price which this surplus will command that governs and fixes the price for the whole ; and as this can not be sold readily—as under such circumstances no one buys in excess of present demand, and all desire to dispose of accumulated stocks—the result is a decline of prices, in accordance with no law, and which will be more or less excessive, or permanent, as opinions vary as to the extent of the surplus and the permanence of the causes that have occasioned it.*

Another illustration to the same effect is afforded in the case of silk, which, according to accepted English statistics, has notably declined in price, comparing the average rates of 1867–'77 with those of 1885, without anything like a corresponding increase in supply. Hence the inference would seem warranted, that some other agency than increased and cheapened production had occasioned the decline in price, and that the case was one which affords support to the gold-scarcity theory. But a careful examination of all the involved circumstances discloses the fact, that within recent years materials other than silk—more especially the "ramie" -fiber—largely enter into the composition of silk fabrications—in the case of the cheaper silks of extensive consumption to the extent of even 60 per cent—and that other methods of adulterating silk, formerly but little known, are now extensively practiced ; all of which is equivalent to increasing the supply of silk for manufacturing, far beyond what commercial reports respecting the supply of the fiber would indicate.

Such, then, are the leading and admitted facts illustrative of the nature and extent of the extraordinary and most extensive decline in prices which has occurred in recent years, and which has been the most apparent and proximate (but not the ultimate) cause of the period of economic disturbance which, commencing in 1873, still exists, and seems certain to last for some time longer. Such, also, is a

* The estimates of Messrs. Helmuth, Swartze & Co., were that the wool product of the world increased from 1871–'75 to 1886—or during a period of from eleven to fifteen years—35 per cent ; while the increase in the world's consumption of wool from 1860 to 1886—a period of twenty-five years—was from 2·03 pounds to 2·66 pounds per head, or in the ratio of 30 per cent.

summary of the evidence in support of the view that this recent phenomenal decline of prices is due so largely to the great multiplication and cheapening of commodities through new conditions of production and distribution, that the influence of any or all other causes combined in contributing to such a result has been very inconsiderable, if not wholly inappreciable. Reasoning also from what may be termed the gold standpoint, the evidence to the same effect is not less conclusive.

It would seem, in the first place, that if the scarcity influence of gold on prices had originated and operated as the advocates of this theory claim, such influence would have been as all-pervasive, synchronous, irresistible, and constant as the influence of gravitation; and that something of correspondence, as respects time and degree, in the resulting price-movements of commodities, would have been recognized. But no such correspondence has been or can be established. On the contrary, the movement of general prices since 1873 —although generally downward—has been exceedingly irregular; declining until 1878–'79; then rising until 1882–'83; then again declining to an almost unprecedented low average in 1886; and in the year 1887 exhibiting, in respect to some commodities, a slight upward tendency. It might also have been expected that the influence of a scarcity of gold would have especially manifested itself at or shortly subsequent to the time (1873–'74) when Germany, having demonetized silver, was absorbing gold, and France and the Latin Union were suspending the coinage of silver. But the years from 1875 to 1879, inclusive, taking the English market as the criterion, were characterized generally by an excessive supply of money and currency of all kinds; and the same has been true of the period from 1880 to 1886–'87, when, if the supply of money from gold was constantly diminishing, contrary results would seem to have been inevitable.

The divergency in the price-movements of different and special commodities has also been very notable—so much so that, out of the long list of articles embraced in the numerous tables that have been prepared by European economists for determining the general average of prices during recent periods, the price-movements of no two commodities can be fairly regarded as harmonizing. While in the case of some staple products, prices fell immediately and rapidly after 1873, the prices of others, although subjected to the same gold-scarcity influence, and which did not have this influence neutralized by a decline of production concurrent with continuing demand, exhibited for a long time comparatively little or absolutely no disturbance. This was especially the case in respect to wool, the price of which, long after metals, breadstuffs, chemicals, and cotton goods had succumbed to the wave of depression subsequent to 1873, "continued" (to use the language of the trade) "remarkably healthy," notwithstanding a continually-increasing product was recognized; and it was not until 1884

that the decline in the general prices of this commodity gave any occasion for anxiety.

Careful comparisons of price-movements in recent years also fail to show any exact correspondence of results as respects different countries, the average fall of prices having been apparently less in France and Germany than in Great Britain during the same period; while the average fall in prices in the United States, in respect to all those commodities which enter into the general wants of man, have been undoubtedly greater than in any other country.*

Now, while such results are not in accordance with what might have been anticipated *from* and can not be satisfactorily explained *by* any theory of the predominating and depressing influence of a scarcity of gold on prices, they are exactly the results which might have been expected from and can be satisfactorily explained by the conditions of supply and demand—conditions so varying with time, place, and circumstance as to require in the case of every commodity a special examination to determine its price-experience, and which experience, once recognized, will rarely or never be found to exactly correspond with the experience of any other commodity: the leading factor

* The following extract from the "Report of the Chamber of Commerce of Cincinnati, Ohio," for the year ending August 31, 1886, strikingly illustrates the extraordinary decline in the price of staple commodities in this great interior market of the North American Continent:

"There is one condition revealed"—i. e., by the statistics of 1885–'86—"that is very noticeable, which is that prices in general touched the lowest point in a quarter of a century. There were those who supposed that the shrinking processes had been arrested in the preceding year, and yet the figures for 1885–'86, in nearly all departments of business, show lower prices than the previous year. In presence of the low prices of 1884–'85, it seemed almost incredible that so much of market value could be wrung from them as has been during the past year. Thus, commencing near the alphabetical list, bran declined 9 per cent; creamery butter, 20·7; butterine, 18; candles, 18·7; soap, 15·2; cattle, 8; coal, delivered, 7·8; middling cotton, 11·9; feathers, 6·7; dried apples, 27·4; No. 2 mixed (shelled) corn, 14·6; No. 2 oats, 5·3; New Orleans molasses, 11·6; Louisiana rice, 13·1; hay, 5; hops, 25·2; mess-pork, 21·1; prime lard, 10·7; lard-oil, 11·7; tallow, 22; white-leaf tobacco, 25; flax-seed, 18·4; starch, 13·4; high wines, not including the taxes, 16·3. In a few articles—tanners' bark, clover-seed, lead, barley, wool, etc.—there was an advance; yet the number is so small as to make them quite exceptionable.

"While the depreciation which has taken place the past year (1885–'86), compared with the prices of 1884–'85 has been marked, it may be interesting to take a glance at the tremendous reduction which has taken place in the past five years, which, in articles that enter into the every-day wants of man, in not a few instances has been equal to almost one half their value in 1881–'82. The gravitation to a lower plane of value has been so steady as to prevent a full appreciation of the enormous shrinkage to which commodities have been subjected. Thus, in mess-pork the depreciation in the general average price since 1881–'82 has been 48·5 per cent; in prime steam lard, 46; hams, 24·4; shelled corn, 43; oats (which in Europe have shown no tendency in recent years to fall in price), 39·4; rye, 32·6; bran, 33·8; extra butter, 46·9; tallow, 41·4; flour, 34·3; linseed oil, 30; salt, 18·6; cheese, 17·1; fair to medium cattle, 18·3; middling cotton, 21·7; Louisiana rice, 28·9; barley, 18·6; and wool, 15 per cent."

occasioning the recent decline in the prices of sugars having been an extraordinary artificial stimulus; in quinine, the changes in the sources of supply from natural to artificially-cultivated trees; in wheat, the accessibility of new and fertile territory, and the reduction of freight; in freights, *on land*, the reduction in the cost of iron and steel, and *on the ocean* new methods of propulsion, economy in fuel and undue multiplication of vessels; in iron and steel, new processes and new furnaces, affording a larger and better product with less labor in a given time; in certain varieties of wool, changes in fashion, and in others an increase of production in a greater ratio than population and their consuming capacity; in ores and coal, the introduction of the steam-drill and more powerful explosive agents; in cheese, a disproportionate market price for butter; in cotton cloth, because the spindles which revolved four thousand times in a minute in 1874 made ten thousand revolutions in the same time in 1885; in "gum-arabic" and "senna," a war in the Soudan; in wines, a destruction of the vines by disease, etc., etc. And yet all these so diverse factors of influence evolve and harmonize under and, at the same time, demonstrate the existence of a law more immutable than any other in economic science—namely, that when production increases in excess of current market demand, even to the extent of an inconsiderable fraction, or is cheapened through any agency, prices will decline; and that when, on the other hand, production is checked or arrested by natural events—storms, pestilence, extremes of temperature—or by artificial interference—as war, excessive taxation, or political misrule or disturbances—prices will advance; and, between these extremes of influence, prices will fluctuate in accordance with the progressive changes in circumstances and the hopes and fears of producers, exchangers, and consumers.*

It should also not be overlooked that extraordinary price-movements—mainly in the direction of further decline, and as the result of continually changing conditions in the production and supply of commodities—are constantly occurring, and are likely to continue to occur, unless further material progress is in some way to be arrested. Bes-

* In new countries, or countries where industry is confined to the production of a few staple products, like wool, wheat, sugar, etc., a decline in prices exerts a wider and much more disturbing influence than in countries where there is great diversity of industry, and where the sources of income and the opportunities for employment are more numerous and more varied. In the latter all branches of industry are rarely depressed at the same time, and prosperity in some compensates to a certain extent for adversity in others. But, in countries of inferior industrial organization and diversification, the interests of the entire community are so common and united that the tendency is always, for a change of price in one commodity—either rise or fall—to unduly influence the prices of all commodities. And this, according to the London "Statist," is what has been particularly noticeable in Australia, where such a sympathy obtains between the three great products of that country—wool, wheat, and copper—that it rarely happens that one of them droops in price without the price of the others rapidly weakening.

semer-steel rails, which commanded £4 5*s.* in Great Britain in 1886, sold in Belgium in June, 1887, for £3 16*s.*; sugar, which was thought to have touched the lowest possible price in July, 1886—2·92 cents per pound in New York (for fair refining in bond), sold in July, 1887, in the same market, for 2·37½ cents; Western (United States) creamery butter which brought 27½ cents in November, 1886, declined to 19 cents in July, 1887; while sulphate of quinine, which sold in 1885 for 2*s.* 6*d.* per ounce (60 cents), in 1887, owing to continued cheapening in the production and transportation of cinchona-barks and improvements in manufacture, by which more quinine can be made in from three to five days' time than could, a year or two ago, be produced in twenty by old processes, sells for 1*s.* 8*d.* (40 cents), and one of the largest of the world's manufacturers of quinine, under date of September, 1887, writes, "No one can predict the future of this product, as all past experience goes for naught."

But a more interesting question, and one more pertinent to this discussion than any other, is: has gold, in recent years, as an instrumentality for effecting exchanges (by measuring the relation between the various commodities and things exchanged), really become scarce—at least to the extent of occasioning, through its increase of value or purchasing power, a considerable fall in the prices of all commodities? And on this point the following is a summary of the evidence in favor of and in contravention of such a supposition.* The position taken by the advocates or believers in the gold-scarcity theory, is, in brief, that the production of gold in recent years has largely fallen off and become wholly inadequate to meet the demands for coinage contingent on the increase in the world's trade, wealth, and population; and further, and as a direct consequent, that trade everywhere has been obstructed and depressed; that prices, profits, and wages have fallen, and the burden of public debts and of taxation in general has been augmented.

That the world's annual product of gold—consequent mainly upon the exhaustion of the mines of California and Australia—has largely diminished in recent years is not disputed. Opinions as to the extent of this reduction of supply are, however, widely at variance. This is illustrated by the following tables presented in the "First Report of the British Commission on the Recent Changes in the Relative Values

* To avoid confusion of ideas on this subject, it is desirable that the reader should keep clearly in view that *price* is the expression of the value of a commodity in terms of money, and that the expressions, "fall in prices" and "appreciation of gold," for purposes of the present discussion, mean really one and the same thing. "If you have a fall in prices, you have an appreciation of gold; and if you have an appreciation of gold, you have a fall in prices." The problem presented is, therefore, not has gold appreciated in value or purchasing power—for, a fall in prices being admitted, such a result becomes inevitable and coincident—but has its appreciation been due to something that has befallen commodities, or something that has befallen gold itself, such as scarcity of supply or extraordinary demand?

of the Precious Metals," which gives the estimates of Messrs. Soetbeer, of Germany, and Pixley, of London, two of the best recognized authorities on this subject, as to the average yearly amount of gold available for the supply of coin at different periods since 1850:

Soetbeer.		Pixley.	
1857–'60	£22,780,000	1852–'60	£27,600,000
1861–'70	14,060,000	1861–'70	17,600,000
1871–'80	10,255,000	1871–'80	18,700,000
1881–'84	4,050,000	1881–'85	11,200,000

That trade, in the sense of diminishing volume, has *not* been obstructed, and that the decline in prices in recent years has *not* been occasioned, to any appreciable extent, by reason of the scarcity of gold, would appear to be demonstrated by the evidence that has been herewith presented. For the assertion that wages, generally, have fallen, there is absolutely no foundation, as will be shown hereafter. That profits have fallen must be admitted; but such a result has been due, in almost every case, to the severe competition engendered by the desire to effect sales in face of a continued supply of commodities in excess of any current market demand. While in contravention of the assumption that the supply of gold in recent years has been inadequate to meet the increased demands of the world for coinage, etc., the following facts are in the highest degree pertinent, if not wholly conclusive:

No one doubts that the amount of gold in the civilized countries of the world has largely increased in recent years. M. Soetbeer names $538,000,000 as the increase from 1877 to 1885. It is absolutely certain that the reserves of gold in the principal banks of Europe and the United States have in recent years largely increased, and not diminished. Professor Laughlin estimates this increase to have been "from $477,000,000 in 1870–'80 to $836,000,000 in 1885." In 1871–'74 there was, according to the same authority, "$1 in gold for every $3.60 of the paper circulation of the banks of the civilized world; in 1885 there was $1 of gold for every $2.40; the total note circulation increasing during the same time to the extent of $464,000,000, or 29 per cent." In 1870–'74 the gold reserves amounted to 28 per cent of the total note circulation, and 64 per cent of all the specie reserves; in 1885 "the gold bore a larger ratio to a larger issue of paper, or 41 per cent of the total note circulation, and 71 per cent of the specie reserves. This," as Professor Laughlin remarks, "is a very significant showing. What it means, beyond a shadow of doubt, is that the supply of gold is so abundant that the character and safety of the note circulation has been improved in a signal manner."

Since 1873–'74 Germany has radically modified her metallic circulation, giving preference to and using additional gold, and the United States and Italy have resumed specie payments. But the supply of

gold has been sufficient to give to these nations all the gold that they required, without apparently affecting the requirements of other countries.

Again, while the continuing increase in the population of the world, and a more rapid increase in recent years in its production and trade, have certainly necessitated a continually increasing supply of money for effective exchanges, evidence is not wanting to prove that all such requirements have been met and any possible deficiencies in the supply of metallic money fully supplemented through various agencies. The present annual production of gold is enormous compared with any period antecedent to 1850.* Before 1840 its annual production was about $14,000,000; it rose to its highest point—$157,000,000—about 1853; and for the year 1885 (according to the estimate of the Director of the United States Mint) was $101,500,000. The production of silver has also largely increased in recent years ($39,000,000 in 1850, $51,000,000 in 1870, and $124,900,000 in 1885), and no evidence can be produced to show that there has been any actual diminution in its aggregate use by reason of its so-called "demonetization" in any country.

Never before in the history of the world have there been so many and such successful devices invented and adopted for economizing the use of money. Every increase in facilities for banking and for the granting and extension of credits largely contributes to this result; the countries enjoying the maximum of such facilities requiring the smallest comparative amount of coin for their commercial transactions, as is illustrated by the circumstance that while in Great Britain (according to Mulhall) the ratio of metallic money used to the whole commerce of the country is only 20 per cent, the ratio rises in Germany to 34 per cent, in the United States to 58 per cent, and in France to 85 per cent.

Furthermore the banking facilities of the world, according to the same authority, have increased since 1840 eleven-fold; or three times greater than the increase in commerce, and thirty times greater than that of population.

The great reduction in the time and cost of distribution of commodities, and the facility with which purchases can be made and credits transmitted by telegraph, have also resulted, not only in an enormous saving of capital, but also in an ability to transact an increased business with diminished necessity for the absorption and use of actual money. A most striking illustration in proof of this, given by Mr. Fowler ("Appreciation of Gold," London, 1885) is, that while the total British export and import trade, aggregating £6,000,000,000 from 1866 to 1875, was accompanied by an aggregate export and import of £530,000,000 of bullion and specie, an aggregate value from 1876 to 1885 of £6,700,000,000, was moved with the aid of only £439,000,000

* "In the last thirty-five years, one and one third times as much gold has been produced as in the three hundred and fifty-eight years preceding 1850."—LAUGHLIN.

of bullion and specie. The same authority refers to an eminent English firm doing business with the East, as stating that "their business could now be conducted with one fifth of the capital formerly employed," which would seem to warrant the inference that the reduction in the necessity for using so much of their capital as was represented by money had also been proportionate.

For the settlement of international balances—a large function of gold—it is certain that every ounce of this metal—through the great reduction in the time of ocean-transits—is at the present time capable of performing far more service than at any former period; the time for the transmission of coin and bullion having been reduced in recent years between Australia and England from ninety to forty days, and from New York to Liverpool from twelve or fifteen to eight or nine days. Such an increase of rapidity in doing work is certainly equivalent to increase in quantity.

The statistics of clearing-houses, which are everywhere multiplying, also show a continued tendency for the settlement of financial obligations without the intervention of either notes or coin; while in every country which has adopted the "postal money-order" system the rapidity with which the public resort to that method of effecting exchanges is most surprising.*

In estimating the influence of the diminished production of gold in recent years, it is important to bear in mind a point to which attention has been often heretofore called, and that is, that gold and silver are not like other commodities, of which the greater part of the annual production is annually consumed; but that their use for the purpose of effecting exchanges does not involve consumption, except by loss and wear; that the work they have once done they are equally ready to do over and over again, and that every addition to their stock "is an addition to the fund available for exchanges." The aggregate sum by which the yearly average amount of gold available for coining fell off during the period from 1861–'70 as compared with that from 1852–'60,† when the mines of California and Australia were most productive, was (adopting Mr. Pixley's estimates) less than £100,000,000 ($500,000,000), a sum absolutely great, but most inconsiderable—less than one sixth of one per cent—in comparison with the amount of gold believed to have been in existence in civilized countries in 1885;‡

* The number of "postal"-orders issued by the British Post-Office in 1886 was 18,831,164, representing £7,885,347 ($39,226,735); while money-orders, domestic and foreign, were issued during the same year to the amount of £25,012,337 ($125,061,685). In the countries comprising the Postal Union of Europe, the issue of domestic money-orders had risen in 1885 to the large amount of $1,821,000,000.

† It is interesting to note that the yearly average amount of gold available for coinage was greater, according to Mr. Pixley's estimates, from 1871–'80 than from 1861–'70.

‡ M. Sauerbeck estimates the total amount of gold in the form of coin and bullion in Europe (excluding the Balkan Peninsula), the United States, and Australia, at the end of 1884, to have been £645,000,000 ($3,225,000,000).

and that such deficiency—even if a much higher estimate than that of Mr. Pixley's is adopted—has for each and every year for a considerable period been far more than supplemented and made good by the reduction in the amount of capital, in the form of money, which the increased facilities for doing business have permitted and effected, is a proposition also which it would seem could not well be doubted.*

The evidence, therefore, seems to fully warrant the following conclusions: that the tendency of the age is to use continually less and less of coin in the transaction of business;† and that "so far from there being any scarcity of gold, there never was a period in the world's commercial history when the existing quantity was so large as at present, in proportion to the necessity for its use or the purposes it has to serve."

It is also exceedingly interesting and significant to note here how completely the most distinguished advocate of the desirability of enlarging the function and use of silver in coinage has repudiated the idea that the recent phenomenal decline of prices has been occasioned by a scarcity of gold. Thus, under date of April 24, 1886, M. Cernuschi thus writes in the London "Economist": "The fall of prices which is complained of is not due to what has been called a scarcity of gold—a scarcity which is purely imaginary." M. Sauerbeck, in referring to this matter ("Journal of the Royal Statistical Society," September, 1886), also says: "A scarcity" (of gold) "as understood by bankers does not exist. Prices have fallen so much that scarcity is not observable. As Mr. Giffen pointed out, there may be enough for present requirements, and the scarcity will only be felt when prices rise." But if prices have fallen through the ingenuity of man, will prices return to their former level? Certainly not, unless the coming man is less ingenious than his present representatives, and Nature is to be less generous in the future of her resources.

* "The trade of the world is carried on by credit and capital, and any causes affecting these essentials have infinitely greater effect on prices than a slight proportionate increase or decrease in the production of gold. A merchant may not hold ten sovereigns, but he may have capital and credit for ten millions. An ingenious statistician has calculated the capital of the world in 1880 at £46,000,000,000" (sterling—$230,000,000,000), "and if credit and capital have had the main voice in the question of prices, how minute must have been the effect on the markets of an annual reduction in the production of floating capital of ten (sterling) millions per annum, from a short period of most exceptional production; especially when the falling off has been more than balanced by the increased economy in the use of gold!"—NATHANIEL CORK, "*What is the True Measure of the Alleged Appreciation of Gold?*" *London, 1883.*

† Repeated investigations made in England in recent years prove that only about 0·6 per cent of coin is used in settling the transactions of banks and bankers of that country; and the results of an inquiry instituted by the United States Controller of the Currency in 1881 showed that of all the receipts by 1,966 national banks in one day in that year (June 30th), 95 per cent were made up of forms of credit, exclusive of even circulating notes; while for New York city the percentage was 98·7. At all the banks the proportion of gold coin to the whole receipts was only ·65 of 1 per cent.

The answer of Mr. R. Inglis Palgrave, an English economist of repute, who has recently published extensive memoranda on prices, to a question put to him by the British Gold and Silver Commission (1886), as to "how far the drop in prices is attributable to the alteration in the use of the gold standard," is also worthy of note, and was as follows: "In my opinion it is only a small part of the drop in prices which is attributable to the appreciation of the standard." The present and rapidly increasing indifference of the business public, alike in Europe and the United States, whose interest in this subject is mainly practical, is also significant, as indicating that the importance formerly conceded to the gold-scarcity theory has not been confirmed by experience.

It will be further relevant to this discussion to call attention here to the manner in which certain admitted facts touching the recent fall in prices have been misunderstood, and, more especially, have been perverted, with a view of sustaining this same theory and of creating exaggerated ideas respecting impending disasters, and the power of legislation to provide remedies. Thus, in illustration of the assumption that the quantity of gold in the world, available for use as money, mainly regulates prices, and that, prices having fallen by reason of a scarcity of gold, the ratio of debts to assets, or the burdens upon debtors, has been increased, Mr. Moreton Frewen, of England, has frequently in recent years made the following statement: Premising that the national debt of the United States was £600,000,000 sterling ($3,000,000,000) in 1866, and £220,000,000 ($1,100,000,000) in 1887, he says:

"Six hundred millions sterling owing in 1866 represent 18,000,000 bales of cotton, or 25,000,000 tons of bar-iron. But at the prices of to-day, only £220,000,000 sterling is represented by some 26,000,000 bales of cotton, or 29,000,000 tons of bar-iron."

Therefore, the burden of the national debt of the United States has been increased, as a greater effort of labor, or an increased amount of the products of labor, is now necessary to liquidate it than when the purchasing power of gold had not been appreciated through its scarcity; and, as with public debts, so also with private debts, especially those in the nature of mortgages on land, or other productive fixed capital.

Now, in reply to this it is to be said, *first*, that the basis assumed for this comparison of prices, in the case of cotton, is entirely unfair and unnatural—the *gold* price of this commodity in the year 1866, owing to a scarcity occasioned by war, having been more than 250 per cent higher than the average prices in 1860 before the war; while the price of iron for that same year in the American markets was also inflated on even a gold basis; and, *secondly*, that no consideration is given, or allowance made in the above comparisons for the results of labor at the two periods of 1866 and 1887; not more, and probably

much less, actual labor in 1886–'87 having produced 6,513,000 bales of cotton in the United States than was required in 1860 to produce 3,800,000 bales ; * while in the case of iron the same amount of labor will produce in 1887 more than double the quantity, in the more valuable form of steel, than it could have produced in 1886. In short, if the debtor has got more to pay, he has more to pay with.

Again, it is a popular idea that the steadily increasing supply to the markets of the world during recent years of wheat, the product of low-priced labor from India—seriously affecting, through its competition, the prices and profits alike of the agriculturists of the United States and of Europe—has been in some way occasioned by the change in the relative values or purchasing powers of gold and silver, consequent on the "demonetization" of the latter metal—although no one as yet has been able to trace with any degree of clearness any connection between the two facts—and that an imperative necessity exists for some speedy and international remedial legislation. To all entertaining this idea, the following summary of evidence, brought out by the British Gold and Silver Commission in the course of their investigations prosecuted during the present year (1887), is especially worthy of attention : †

There was practically no trade or movement in wheat between Europe and India until two or three years after the opening of the Suez Canal, or until about 1873 ; in which year exportations were further encouraged by the removal of an Indian export duty on wheat of about 6 per cent. In June, 1881, and June, 1886, the prices of Cawnpore wheat at Calcutta were at the same level, namely, 2·9 rupees per maund. The cost of Indian wheat in London in 1881 was 42*s.* a quarter, and 31*s.* 6*d.* in 1886, or 10*s.* 6*d.* difference. In 1881 the rate of freight on wheat from India to London was 60*s.* per ton, and in 1886 30*s.*, a difference of 30*s.* per ton, or 6*s.* 6*d.* per quarter. The decline in freights, therefore, accounts for 6*s.* 6*d.* out of the 10*s.* 6*d.* per quarter

* The increase in the cotton product of the United States since 1860 has been due mainly to the increased use of fertilizers, better tillage, better conditions for the employment of labor. In the Brazos alluvial region of Texas, which ranks among the first of cotton-producing regions, the relative increase in cotton product and population between 1870 and 1880, according to the United States census, was 1·8 to 1. In what is termed the "oak-upland" regions of North Carolina, the product of cotton in 1880 had increased over that of 1870 in the ratio of 4·5 to 1, or this region in 1880 produced more cotton than the product of the entire State in either 1870 or 1860. "This remarkable result," according to the special United States census report on cotton for 1880, "was due mainly to the introduction and general use of commercial fertilizers, which not only increase the crop, but hasten its maturity from two to three weeks, and so bring into the cotton belt a strip of plateau country whose elevation, of from 800 to 1,200 feet, had placed it just beyond the climatic range of the cotton-plant. This change is in no respect due to altered relations of labor."

† See "First Report of the British Commission"—evidence of Henry Waterfield, C. B., Financial Secretary of the India Office, and representing the Government of India, pp. 125, 126.

difference between the prices of Indian wheat in London in 1881 and 1886, respectively, leaving 4*s.* per quarter to be contributed by other agencies. Between 1879 and 1886 the charge for the railway transport of grain between Cawnpore and Calcutta (684 miles) was reduced to the extent of about 2*s.* per quarter, which represented to the purchaser in Calcutta an equivalent reduction in the cost of Indian production, and in the absence of which the Calcutta and European prices would obviously have been correspondingly increased. A further reduction of 6*d.* per quarter "is probably owing to a decline, during the same period, in the price of the gunny-bags" in which the wheat is transported; leaving 3*s.* 6*d.* per quarter, which may not unreasonably be referred to, and fully accounted for, by the extraordinary decline of more than 12*s.* per quarter, between the years 1880 and 1885, in the export price of American wheat; which, as the largest factor in determining the world's surplus of this commodity, is also necessarily the largest factor in determining what shall be the price of this surplus in the world's market.

Evidence was also submitted to the British Trade Depression Commission in 1866, to the effect that the increase of the acreage under wheat in India "exactly agrees with the development of the Indian railways," and that "when more railways are made in India, a very much larger wheat production will immediately follow."*

* On this subject, the following testimony was submitted to the British Commission on the Depression of Trade, 1886, by Mr. W. J. Harris, who is recognized as an authority in England on agricultural subjects:

"Our Indian Empire seems able to extend its corn-growing industry to almost any extent, and to produce more cheaply than any other country in the world. I am aware that Sir James Caird gave a somewhat different evidence on this question, but I think that neither Mr. Giffen nor Sir James Caird have taken sufficiently into account one or two things in their statistical computation. They both maintain that the population of India is too large, or is getting too large, for the means of production. They do not seem to remember that every unit of population in India consumes about a fifth part of what the unit of population in the United States does. It is a comparison between India and the United States. Both Sir James Caird and Mr. Giffen admit that the capabilities of the United States are very enormous, but they think that the capabilities of India are comparatively very small. I differ from them, and I will give my reasons. If we follow (on the maps of India) the course of the railways which have been made for some time, you will find that the acreage under wheat exactly agrees with the development of those railways; and it appears to me that when more railways are made in India, a very much larger wheat production will immediately follow. I have made several inquiries from the principal merchants who do business with India, and who have agents at many central points, and they all agree that the wheat production in India is not nearly developed yet. The population is not encroaching on the means of subsistence so much as the mere statistician would argue, because he does not take into account the habits of the people; and I believe that the United States population, in consequence of the habits of its people, is encroaching just as fast on their means of subsistence as are the people of India. There is a large acreage in India that is not fully cultivated with anything at the present time, and, where it is, it is very imperfectly cultivated, and the prices of produce are exceeding low in places remote from railway communication. Agriculture is very

The evidence, therefore, warrants the belief that the fall in recent years in the price of Indian wheat, and its consequent appearance as an important element of supply in European markets, is to be accounted for mainly, if not entirely, by changes in the conditions of its production and supply, and not by any changes in the relative values of gold and silver; and further, that if every measure for extending the monetary use of silver, which has been proposed, should be carried out to the fullest extent, it would produce no sensible influence in restraining the Indian ryot from competing with American and European agriculturists in the sale of wheat in the world's markets.

AGASSIZ AND EVOLUTION. *

By Professor JOSEPH LE CONTE.

IN order to clear up the conception of evolution, it is necessary to give a brief history of the idea, and especially to explain the relation of Louis Agassiz to that theory. This is the more necessary, because there is a deep and wide-spread misunderstanding on this subject, and thus scant justice has been done our great naturalist, especially by the English and Germans; and also because this relation is an admirable illustration of an important principle in scientific philosophy.

Like all great ideas, we find the first germs of this in Greek philosophy, in the cosmic speculations of Thales and Pythagoras. Next (about 100 B. C.) we find it more clearly expressed by the Roman thinker, Lucretius, in his great philosophic poem entitled "De Rerum Natura." After a dormancy of nearly eighteen centuries it next emerges with still more clearness in the theological speculations of Swedenborg and the philosophical speculations of Kant. All these we pass over with bare mention, because these thinkers approached the subject from the philosophic rather than the scientific side—in the metaphysical rather than the scientific spirit.

The first serious attempt at scientific presentation of the subject was by the celebrated naturalist, Lamarck, in a work entitled "Philosophie Zoölogique," published in 1809. It is not necessary, in this rapid sketch, to give a full account of Lamarck's views. Suffice it to say that the essential idea of evolution, viz., the indefinite variability and the derivative origin of species, was insisted on with great learning and skill, and illustrated by many examples. With Lamarck, the factors of evolution or causes of change of organic forms were—1. Modification of organs in function and therefore in structure, by a

rude; they have very little machinery. The system might be greatly improved, and the produce thereby increased."—*Third Report on the Depression of Trade, pp. 82, 83.*

* From advance sheets of Professor Le Conte's work on "Evolution and its Relation to Religious Thought," in preparation by D. Appleton & Co.

changing environment—external factor; and, 2. Modification of organs by *use* and *disuse*—internal factor. In both cases the modifications are inherited and increased from generation to generation, without limit. This second factor seems to have taken, in the mind of Lamarck, the somewhat vague and transcendental form of aspiration or upward striving of the animal toward higher conditions. These are acknowledged to-day as true factors of evolution, but the distinctively Darwinian factor, viz., "divergent variation and natural selection," was not then thought of. The publication of Lamarck's views produced a powerful impression, but only for a little while. Pierced by the shafts of ridicule shot by nimble wits of Paris, and crushed beneath the heavy weight of the authority of Cuvier, the greatest naturalist and comparative anatomist of that or perhaps of any time, it fell almost still-born. I believe it was best that it should thus perish. Its birth was premature; it was not fit to live. The world was not yet prepared for a true scientific theory. Nevertheless, the work was not without its effect upon some of the most advanced thinkers of that time; upon Saint-Hilaire and Comte in France, and upon Goethe and Oken in Germany. It was good seed sown and destined to spring up and bear fruit in suitable environment; but not yet.

The next attempt worthy of attention in this rapid sketch is that of Robert Chambers, in a little volume entitled "Vestiges of a Natural History of Creation," published in 1844. It was essentially a reproduction of Lamarck's views in a more popular form. It was not a truly scientific work nor written by a scientific man. It was rather an appeal from the too technical court of science to the supposed wider and more unprejudiced court of popular intelligence. It was therefore far more eloquent than accurate; far more specious than profound. It was, indeed, full of false facts and inconsequent reasonings. Nevertheless, it produced a very strong impression on the thinking, popular mind. But *it* also quickly fell, pierced by keen shafts of ridicule, and crushed beneath the heavy weight of the authority of all the most prominent naturalists of that time, with Agassiz at their head. The question for the time seemed closed. I believe, again, it was best so, for the time was not yet fully ripe.

I know full well that many think with Haeckel that biology was kept back half a century by the baneful authority of Cuvier and Agassiz; but I can not think so. The hypothesis was contrary to the facts of science *as then known and understood.* It was conceived in the spirit of baseless speculation, rather than of cautious induction; of skillful elaboration rather than of earnest truth-seeking. Its general acceptance would have debauched the true spirit of science. I repeat it: the time was not yet ripe for a scientific theory. The ground must first be cleared and a solid foundation built; an insuperable *obstacle* to hearty rational acceptance must first be removed, and an inductive *basis* must be laid.

The obstacle in the way of the acceptance of the derivative origin of species was the then prevalent *notion concerning the nature of life.* We must briefly sketch the change which has taken place in the last forty years in our ideas on this subject.

Until about forty years ago, the different forces of Nature, such as gravity, electricity, magnetism, light, heat, chemical affinity, etc., were supposed to be entirely distinct. The realm of Nature was divided up into a number of distinct and independent principalities, each subject to its own sovereign force and ruled by its own petty laws. About that time it began to be evident, and is now universally acknowledged, that all these forces are but different *forms* of one, universal, omnipresent energy, and are transmutable into one another back and forth without loss. This is the doctrine of correlation of forces and conservation of energy, one of the grandest ideas of modern times. But *one* force seemed still to be an exception. Life-force was still believed to be a peculiar, mysterious principle or entity, standing above other forces and subordinating them; not correlated with, not transmutable unto, nor derivable from, other and lower forces, and therefore in some sense supernatural. Now, if this be true of living *forces*, it is perfectly natural, yea, almost necessary, to believe that living *forms* are wholly different from other forms in their origin. New forms of dead matter may be derived, but new living forms are *underived.* Other new forms come by natural process, new organic forms by supernatural process. The conclusion was almost unavoidable. But soon vital force also yielded to the general law of correlation of natural forces. Vital forces are also transmutable into and derivable from physical and chemical forces. Sun-force, falling on the green leaves of plants, is absorbed and converted into vital force, disappears as *light* to reappear as *life.* The amount of life-force generated is measured by the amount of light extinguished. The same is true of animal life. As in the steam-engine the locomotive energy is derived from the fuel consumed and measured by its amount, so in the animal body the animal heat and animal force are derived from and measured by the food and tissue consumed by combustion. Thus, vital force may be regarded as so much force withdrawn from the general fund of chemical and physical forces, to be again refunded without loss at death. This obstacle is, therefore, now removed. If vital force falls in the same category as other natural forces, there is no reason why living forms should not fall into the same category in this regard as other natural forms. If new forms of dead matter are derived from old forms by modification, according to *physical* laws, there is no reason why new living forms should not also be derived from old forms by modification according to *physiological* laws. Thus, at last, the obstacle was removed—the ground was cleared.

But Science is not content with removal of *a priori* objections. She must also have positive proofs. The ground must not only be

cleared, but a true inductive basis of facts, and especially of laws and methods, must be laid. *This was the life-work of Agassiz.* Yes, as strange as it may seem to some, it is nevertheless true that the whole inductive basis, upon which was afterward built the modern theory of evolution, was laid by Agassiz, although he himself persistently refused to build upon it any really scientific superstructure. It is plain, then, that all attempts at building previous to Agassiz's work must, of necessity, have resulted in an unsubstantial structure—an edifice built on sand, which could not and ought not to stand. I must stop here in order to explain somewhat fully this important point, and thus to give due credit to the work of Agassiz.

The title of any scientist to greatness must be determined, not so much by the multitude of new facts he has discovered as by the new laws he has established, and especially by the new methods he has inaugurated or perfected. Now, I think it can be shown that to Agassiz, more than to any other man, is due the credit of having *established the laws of succession of living forms* in the geological history of the earth—laws upon which must rest any true theory of evolution. Also, that to him, more than to any other man, is due the credit of having *perfected the method* (method of comparison) by the use of which alone biological science has advanced so rapidly in modern times. This is high praise. I wish to justify it. I begin with the method.

Scientific methods bear the same relation to *intellectual progress* that tools, instruments, machines, mechanical contrivances of all sorts, bear to *material progress.* They are intellectual *contrivances*—indirect ways of accomplishing results far too hard for bare-handed, unaided intellectual strength. As the civilized man has little or no advantage over the savage in bare-handed strength of muscle, and the enormous superiority of the latter in accomplishing material results is due wholly to the use of mechanical contrivances or machines; even so, in the higher sphere of intellect, the scientist makes no pretension to the possession of greater unaided intellectual strength than belongs to the uncultured man, or even perhaps to the savage. The amazing intellectual results achieved by science are due wholly to the use of intellectual contrivances or scientific methods. As in the lower sphere of material progress the greatest benefactors of the race are the inventors or perfecters of new mechanical contrivances or *machines,* so also in the higher sphere of intellectual progress the greatest benefactors of the race are the inventors or perfecters of new intellectual contrivances or *methods of research.*

To illustrate the power of methods, and the necessity of their use, take the case of the *method of notation,* so characteristic of mathematics, and take it even in its simplest and most familiar form: Nine numeral figures, having each a value of its own, and another dependent upon its position; a few letters, a and b, and x and y, connected by symbols, $+$ and $-$ and $=$: that is all. And yet, by the use of

this simple contrivance, the dullest school-boy accomplishes intellectual results which would defy the utmost efforts of the unaided strength of the greatest genius. And this is only the simplest tool-form of this method. Think of the results accomplished by the use of the more complex machinery of the higher mathematics!

Take next the method of experiment so characteristic of physics and chemistry. The phenomena of the external world are far too complex and far too much affected by disturbing forces and modifying conditions to be understood at once by bare, unaided intellectual insight. They must first be simplified. The physicist, therefore, contrives artificial phenomena under ideal conditions. He removes one complicating condition after another, one disturbing cause and then another, watching meanwhile the result, until finally the necessary condition and the true cause are discovered. On this method rests the whole fabric of the physical and chemical sciences.

But when we rise still higher, viz., into the plane of life, the phenomena of Nature become still more complex and difficult to understand directly; and yet just here, where we are the most powerless without some method, our method of experiment almost wholly *fails us.* The phenomena of life are not only far more complex than those of dead matter, but the conditions of life are so nicely adjusted, the equilibrium of forces so delicately balanced, that, when we attempt to introduce our clumsy hands in the way of experiment, we are in danger of overthrowing the equilibrium, of destroying the conditions of the experiment, viz., life; and then the whole problem falls immediately into the domain of chemistry. What shall we do? In this dilemma we find that Nature herself has already prepared for us, ready to hand, an elaborate series of simplified conditions equivalent to experiments. The phenomena of life are, indeed, far too complex to be at once understood—the problem of life too hard to be solved—in the higher animals; but, as we go down the animal scale, complicating conditions are removed one by one, the phenomena of life become simpler and simpler, until in the lowest microscopic cell or spherule of living protoplasm we finally reach the simplest possible expression of life. The equation of life is reduced to its simplest terms, and now, if ever, we begin to understand the true value of the unknown quantity. This is the natural history series, or *Taxonomic* series, already spoken of. Again, Nature has prepared, and is now preparing daily before our eyes, another series of gradually simplified conditions. Commencing with the mature condition of one of the higher animals—for example, man—and going backward along the line of individual history through the stages of infant embryo, egg, and germ—we find again the phenomena of life becoming simpler and simpler, until we again reach the simplest conceivable condition in the single microscopic cell or spherule of living protoplasm. This, as already explained, is the embryonic or *Ontogenic* series. Again,

that there be no excuse for man's ignorance of the laws of life, Nature has prepared still another series; and this the grandest of all, for it is the cause of both the others. Commencing with the plants and animals of the present epoch, and going back along the track of geological times, through Cenozoic, Mesozoic, Palæozoic, Eozoic, to the very dawn of life—the first syllable of recorded time—and we find again a series of organic forms growing simpler and simpler, until, if we could find the very first, we would undoubtedly again reach the simplest condition in the lowest conceivable forms of life. This, as we have already seen, is the geologic or evolution, or *Phylogenic* series. We have already explained these three series, only in this connection it suits our purpose to take the terms backward.

Now, it is by *comparison* of the terms of each of these series going up and down, and watching the first appearance, the growth, and the perfecting of tissues, organs, functions, and by the comparison of the three series with one another, term by term—I say it is wholly by comparison of this kind that biology has in recent times become a true inductive science. This is the "*method of comparison.*" It is the great method of research in all those departments which can not be readily managed by the method of experiment. It has already regenerated biology, and is now applied with like success in sociology under the name of *historic method.* Yes; anatomy became scientific only through comparative anatomy, physiology through comparative physiology, and embryology through comparative embryology. May we not add, sociology will become truly scientific only through comparative sociology, and psychology through comparative psychology?

Now, while it is true that this method, like all other methods, has been used, from the earliest dawn of thought, in a loose and imperfect way, yet it is only in very recent times that it has been organized, systematized, perfected, as a true scientific method, as a great instrument of research; and the prodigious recent advance of biology is due wholly to this cause. Now, among the great leaders of this modern movement, Agassiz undoubtedly stands in the very first rank. I must try to make this point plain, for it is by no means generally understood.

Cuvier is acknowledged to be the great founder of comparative anatomy. He it was that first perfected the method of comparison, but comparison only in one series—the *Taxonomic.* Von Baer and Agassiz added to this, comparison in the ontogenic series also, and comparison of these two series with each other, and therefore the application of embryology to the classification of animals. If Von Baer was the first announcer, Agassiz was the first great practical worker by this method. Last and most important of all, in its relation to evolution, Agassiz added *comparison in the geologic or phylogenic series.* The one grand idea underlying Agassiz's whole life-work was the essential identity of the three series, and therefore the light which

they must shed on one another. The two guiding and animating principles of his scientific work were—1. That the embryonic development of one of the higher representatives of any group repeated in a general way the terms of the taxonomic series in the same group, and therefore that embryology furnished the key to a true classification; and, 2. That the succession of forms and structure in geological times in any group is similar to the succession of forms and structure in the development of the individual in the same group, and thus that embryology furnishes also the key to geological succession. In other words, during his whole life, Agassiz insisted that the laws of embryonic development (ontogeny) are also the laws of geological succession (phylogeny). Surely this is the foundation, the only solid foundation, of a true theory of evolution. It is true that Agassiz, holding as he did the doctrine of permanency of specific types, and therefore rejecting the doctrine of the derivative origin of species, did not admit the causal or natural relation of phylogenic succession to embryonic succession and taxonomic order as we now believe it—it is true that for him the relation between the three series was an intellectual not a physical one—consisted in the preordained plans of the Creator, and not in any genetic connection or inherited property; but evidently the first and greatest step was the discovery of the relation itself, however accounted for. The rest was sure to follow.

But more. Not only did Agassiz establish the essential identity of the geologic and embryonic succession, the general similarity of the two series, phylogenic and ontogenic, but he also announced and enforced all the formal laws of geologic succession (i. e., of evolution) as we now know them. These, as already stated and illustrated, are the law of differentiation, the law of progress of the whole, and the law of cyclical movement, although he did not formulate them in these words. No true inductive evidence of evolution was possible without the knowledge of these laws, and for this knowledge we are mainly indebted to Agassiz. He well knew also that they were the laws of embryonic development and therefore of evolution; but he avoided the word evolution, as implying the derivative origin of species, and used instead the word *development*, though it is hard to see in what the words differ. Thus, it is evident that Agassiz laid the whole foundation of evolution, solid and broad, but refused to build any scientific structure on it; he refused to recognize the legitimate, the scientifically necessary outcome of his own work. Nevertheless, without his work a scientific theory of evolution would have been impossible. Without Agassiz (or his equivalent), there would have been no Darwin.

There is something to us supremely grand in this refusal of Agassiz to accept the theory of evolution. The opportunity to become the leader of modern thought, the foremost man of the century, was in his hands, and he refused, because his religious, or, perhaps better, his philosophic intuitions, forbade. To Agassiz, and, indeed, to all men

of that time, to many, alas! even now, evolution is materialism. But materialism is atheism. Will some one say, the genuine Truth-seeker follows where she seems to lead, *whatever be the consequences?* Yes; whatever be the consequences to one's self, to one's opinions, prejudices, theories, philosophies, but not to *still more certain truth.* Now, to Agassiz, as to all genuine thinkers, the existence of God, like our own existence, is more certain than any scientific theory, than anything can possibly be made by proof. From his standpoint, therefore, he was right in rejecting evolution as conflicting with still more certain truth. The mistake which he made was in imagining that there was any such conflict at all. But this was the universal mistake of the age. A lesser man would have seen less clearly the higher truth and accepted the lower. A greater man would have risen above the age, and seen that there was no conflict, and so accepted both. All thinking men are coming to this conclusion now, but none had done so then.

Now, then, at last, the obstacle of supernaturalism in the realm of Nature having been removed by the establishment of the doctrine of correlation of natural forces, and the extension of this doctrine to embrace also life-force; and now also a broad and firm basis of carefully-observed facts and well-established laws of succession of organic forms having been laid by Agassiz, when again, for the third time, the doctrine of origin of species "by derivation with modifications" was brought forward by Darwin in a far more perfect form, with more abundant illustrative materials, and with a new and most potent factor of modification—viz., divergent variations and natural selection—it found the scientific world already fully prepared, and anxiously waiting. I say *anxiously* waiting—for the supposed supernatural origin of species had been the one exception to the otherwise universal law of cause and effect, or the law of continuity. It was therefore an open contradiction to the whole drift of scientific thought for five hundred years. Is it any wonder, then, that the derivative origin of species was welcomed with joy by the scientific world? For five hundred years, scientific thought, like a rising tide which knows no ebb, had tended thitherward with ever-increasing pressure, but kept back by the one supposed fact of the supernatural origin of species. Darwin lifted the gate, and the in-rushing tide flooded the whole domain of thought.

What, then, is the place of Agassiz in biological science? What is the relation of Agassiz to Darwin—of Agassizian development to Darwinian evolution? I answer, it is the relation of formal science to physical or causal science. Agassiz advanced biology to the *formal* stage; Darwin carried it forward, to some extent at least, to the *physical* stage. All true inductive sciences in their complete development pass through these two stages. Science in the one stage treats of the *laws* of phenomena; in the other, of the *causes* or explanation of these laws. The former must precede the latter, and form its founda-

tion; the latter must follow the former, and constitute its completion. The change from the one to the other is always attended with prodigious impulse to science.

To illustrate: Until Kepler, astronomy was little more than an accumulation of disconnected facts concerning celestial motions—abundant materials, but no science; piles of brick and stone, but no building. Kepler reduced this chaos to beautiful order and musical harmony by the discovery of the three great laws which bear his name, and therefore he has been justly called the legislator of the heavens—*the lawgiver of space.* But, had he been asked the *cause* of these beautiful laws, he could only have answered, "The *first cause*—the direct will of the Deity." A good answer and a true, but not scientific; because it places the question beyond the domain of science, which deals only with second or physical causes. But Newton comes forward and gives a *physical cause.* He shows that all these beautiful laws are the necessary result of gravitation; and thus astronomy becomes a physical science. So, until Agassiz, the facts of geological succession of organic forms were in a state of lawless confusion. Agassiz by establishing the three great laws of succession, which ought to bear his name, reduced this chaos to order and beauty; and, therefore, he might justly be called the legislator of geological history—the *lawgiver of time.* But, when asked the cause of these laws, he could only answer, and did indeed answer, "The plans of the Creator." A noble answer and true, but not scientific. Darwin now comes forward and gives, partly at least, the cause of these laws. He shows that all these beautiful laws are explained by the doctrine of "origin of species by derivation with modifications"; that these laws are not ultimate, but derivative from more fundamental laws of life; and thus biology is advanced one step, at least, toward the causal stage. Newton and Darwin substituted second causes for first cause—natural for supernatural. They each in his own department broke the bonds of supernaturalism in the domain of Nature.

One more important reflection: There are two, and only two, fundamental conditions of material existence—*space* and *time.* There are, therefore, two, and only two, cosmoses—space-cosmos and time-cosmos. These have been redeemed from confusion and reduced to law and order and beauty—changed from chaos to cosmos—by science. For this result we are chiefly indebted, in the one case, to Kepler and Newton; in the other, to Agassiz and Darwin. The universal law, in the one cosmos, is the *law of gravitation;* in the other, the *law of evolution.* Traced by analysis to its deepest roots of philosophic truth, the one law may be called the divine mode of sustentation; the other, the divine process of creation.

Or, again: we have all heard of the "music of the spheres"—a beautiful and significant name used by the old thinkers for the divine order of the universe—a music heard not by human ear, but only

by the attentive human spirit. Harmonic relation apprehended by *reason* we call *Law*, and its embodiment Science; the same apprehended by the imagination and æsthetic sense, we call *Beauty*, and its embodiment *Art, music*. Now, in music there are two kinds of harmony, simultaneous and consecutive—chordal harmony and melody. These must be combined to produce the grandest effect. So in cosmic order, too, there are two kinds of harmonic relation—the *coexistent in space* and the *consecutive in time*. The law of gravitation expresses the universal harmonic inter-relation of *objects* coexistent in space, the law of evolution, the universal harmonic relation of *forms* successive in time. Of the divine spheral music, the one is the chordal harmony, the other the consecutive harmony or melody. Combined they form the divine chorus which "the morning stars sang together."

SPECIALIZATION IN SCIENCE.

By Professor G. H. THEODOR EIMER.

A JESUIT with whom I was conversing on educational questions once told me, in depreciation of my position as a man of science, that the naturalist of to-day can be a physiologist or a physicist, mineralogist, geologist, zoölogist, botanist, or chemist, and no more; that he can not overlook the whole of science, but can at most only really know a part of his own branch, from which he is not, of course, justified in drawing any general conclusion. It was otherwise with the Jesuit, who excluded himself from no department of knowledge. This man touched accurately what is now recognized as a growing peril to the general significance of science in mental development—the continuous contraction of the individual's field of labor, or specializing. It is right for naturalists in these days to make themselves masters in their own branch, and masters usually in that alone, unless they are in a position to obtain a survey over the whole of the sciences. But it is wrong, in the present condition of knowledge, to deny them a general acquaintance with all scientific matters. That would be to put their capacity below that of the Jesuit, who only desires to obtain a superficial view of science in order to aid him in holding his position in sophistical disputations against it and in favor of his own dogma. Most naturalists and scientifically educated persons have, moreover, been trained in a liberal range of studies, and are well qualified to form a judgment on general scientific as well as upon important and fundamental philosophical questions. Yet we are living, to a large extent, upon the provision left by the fathers. The dividing up is daily becoming more and more minute, and is destined in time to throw a broad shadow over the outlook, unless the demand for a many-sided basis of training as a defense against the evil is universally insist-

ed upon. It is not necessary to have always at hand, at every moment of life, all the details of knowledge which one has once made his own, any more than it is to put what one learns to immediate practical use; if it were so, we should be at a loss to determine the value of the gymnasial training which demands the best of the time and the best of the strength of our youth. This principle, and the danger of promoting a one-sided practical training, in specialties, as opposed to general culture and more ideal views of life, were entirely lost sight of when the Imperial Government a few years ago made the far-reaching step in the direction—which was itself opposed from the practical side—of curtailing the required preparatory scientific instruction of physicians.

From this point of view the words receive a new prominence, which State Minister Von Gossler recently spoke in welcoming the fifty-ninth meeting of the German Naturalists and Physicians to Berlin. "The number of those," he said, "who have accurately mastered most of the branches of science seems to be growing less, and the question whether another mind will ever appear who will be able to write a 'Cosmos' for his time is becoming harder to answer. And yet the conviction remains inextinguishable that there is a 'Cosmos' and there must be a 'Cosmos.' It is certainly necessary that an incessant accumulation of scientifically ascertained facts shall continue to go on, whether by the way of logical comparison or by the aid of the imagination, and lead to the acquisition of new theories and new conceptions. But the other principle is just as valid, that the essential nature and the law of what is can not be apprehended without a harmonious intimate association of the individual sciences; and the perception is perhaps constantly becoming more clear that the separation among the branches of knowledge has its ultimate reason in the limitations and finitude of human power. Where we formerly thought we were in the presence of a number of forces and unknown causes, we now try to discern one force in different forms of manifestation; and we can not exclude the thought that the great progress that can be shown in single branches of science, is in many respects a kind of induction effect of that which is made in other branches."

These are golden words, which might well be applied by the state in the training of its citizens—particularly in the circle of the higher schools. Is it not by specializing carried to an extreme that our gymnasial teachers have devoted themselves to the ancient languages, till they are hardly competent to do any better work than to carry youth through these, their specialties during nine years, without their pupils giving a glance at the all-forming spirit of Nature around them? Let me be permitted to add to Minister Von Gossler's expressions a word of protest against this most untimely and damaging of all specializing, in favor of the sciences, which are treated by the schools in so stepmotherly a way. There is an impression still current that scientific training is mischievous to the "peaceful citizen"; that it fits him to

plot against the order of the state, or leads him to adopt extreme views in politics and religion. On the contrary, I believe that the importance and value of scientific training must be recognized by every unprejudiced observer in the sound, tolerant, temperate bearing which scientifically educated members of society maintain with reference to questions of public life; which is evident both in itself and as compared with the bearing of men in other conditions. Nothing promotes free, independent thought in men, so well as the sense of obligation to the demands of the generality, so much as the knowledge of the great diversity with unity and the all-prevailing order that rule in Nature. Against the demands of priestly rule and anarchical lawlessness, natural science asks for freedom of movement and orderly subjection, insisting that both are necessary conditions. It must be conceded that neither the order of the theologians nor that of the Jesuits, notwithstanding the nature of both in principle inclines to the conservative rule, affords relatively so few representatives of extreme or radical tendencies as that of the naturalists. The time certainly can not be far distant when the natural sciences shall be given a very different position from that they now hold in general education. Only they can, in the future, furnish the basis, which is becoming more needed as the significance of our public life increases, for the removal of unnatural contradictions in the thoughts of men, for the bringing on of sound, practical, and likewise ideal—I might say, normal—views on the fundamental questions of human society and human life; after exclusive theological and philosophical instruction in these matters has been abrogated.

What an amount of contention, strife, misunderstanding, and hostility among men might have been extinguished or prevented by a more general knowledge of the relative importance of natural processes and laws! Yet the great majority—and of "educated" men, too—even in Germany, die without having obtained more than a vague knowledge of the structure and functions of their own bodies, and that only serving to the preservation of bodily health. And this deficiency is associated through life with the erroneous and cruel doctrine that there is an impassable gap between man and the rest of Nature; while the best force of instruction is wasted upon fruitless philosophical speculations that contradict the most incontestable principles of natural science. Still these zealots demand for their faith the right to stand at the head of the schools and of the state. Should it not be the task of the state to provide for the filling up of the gulf which is thus kept open amid the most fundamental ideas of men, by means of an education conducted on a scientific basis? But the state unwittingly fosters these contradictions of spirit and fritters away its resources, when it leaves its most important representatives, the jurists, who, by the practical nature of their calling and the many-sided character of their relationships, should have the broadest fundamental

training, to grope in as complete a childish ignorance of natural things as the narrowest specialists in the service. That we of the present day in Germany have made so little advance in obtaining for science its proper place in education is certainly not least due to the reserve which our learned men usually observe with reference to questions of public life, and especially to their voluntary burial of themselves in special fields.

It is persistent application to special work that naturally forces the student so far away from all contact with things without, and which, while it makes him a monarch on his own little field, frequently also makes his circuit too narrow and himself too self-important. It is not my purpose to condemn the specializing of science, and occupation with a single branch, in themselves. The more a man studies one thing, the more he sees in it; and the investigator who has engaged himself assiduously with one object sees in it a whole world, in the view of which all other things pass from notice. It is a joy to work in this way on one's own field, and it is also necessary for every one to undergo rigorous schooling in such exercises, especially previous to appearing before the world with any general treatise. Tendencies like that of contemporary science toward specializing are naturally inevitable. The time will come again in which the pressure will in like manner impel students, sifting out the now concluded results of science, to work them up into a whole.

It is, however, not doubtful that the majority of students, so far at least as they are public teachers, to-day go too far in their specializing. Whoever uninterruptedly looks upon a single thing year after year learns no more of the whole. Not alone that the view over science is wholly lost to him, but even in his own branch is such a man at last no longer able to be at home. It is almost the fashion to-day, as among the zoölogists and botanists, for example, no longer to make themselves acquainted with entire animals and plants. At all events, many zoölogists of the day—and the same is the case with the botanists in their sphere—have hardly ever accurately examined an animal as a whole; but they have with the microtome dissected ever so many animals of a group into fine slits, have pulled them to pieces with the needle under the microscope, and have described their observations in monographs. Every one who has done this kind of work in any considerable degree, as has the present writer, must know that while it is going on there is not much time left for the learning of other things. I will not go too deeply into the merits of the work in itself—it must be done. But I hold that in the immediate present it has become too exclusively predominant.

Hand-in-hand with the exaggeration of special work goes the growing inability to write understandingly to the general public. The German student appears only too often to think that he must present his subject in the most difficult phraseology, excessively interlarded

with strange words, as if he purposely would permit a glance into the treasures of his science and his knowledge only to an extremely narrow circle. Nothing better shows this than the style of most of our (German) text-books when compared with that of the majority of the English books, which nevertheless are not behind ours in thoroughness. Even once to write something "popular"—who does not know how many of our students look loftily down upon this art? Now I think it is a valuable art, and worthy of recognition. It can not be expected that every one shall become possessed of it, and every one shall exercise it; but the art is very often wanting simply because exclusive devotion to "purely scientific" work in some extremely narrow field of knowledge has prevented its ever having been put in practice. Many also deliberately hold themselves aloof from it because whoever among us writes understandingly to the public appears to compromise his reputation as a man of science.

Why is it entirely different in England? Why do the first men of science there—those who are recognized and admired by the German scientific world—write understandingly to every one? Who does not enjoy the famous essays of Faraday on "A Candle," of Tyndall on "The Forms of Water," of Huxley on "The Crayfish," etc.? I do not forget that there are also a few scientific men having this talent among us, but they do not escape the shrugs of their contemporaries. It is true that a student who should make such general representation his principal work would soon forfeit his importance as an investigator. But it is also desirable, on the other hand, that the naturalist should not exhaust himself in the examination of details, but that he should, for the sake of keeping himself fresh, come forward with his conclusions from time to time immediately before the cultivated world, and not let the great value of his investigations be recognized by strangers only. In sequence with this general reserve of students—besides the resulting deficiencies in scientific school-instruction—exists also a backwardness among our laymen in expressing themselves respecting their observations of Nature. Nature invites every one to observation and reflection; and even the inexpert inquirer is not excluded from the privilege of being led up to the noblest experiences through this observation and reflection. What does not scientific zoölogy, to mention but one example, owe to the bee-master, Pastor Dzierzon, for his determination of the parthogenesis of bees? And did not Goethe, without being a professional naturalist, arrive at his famous fruitful ideas of the composition of the skull out of vertebræ, of the human intermaxillary, and of the tracing of the parts of the plant back to the leaf? He repeatedly expresses in plain terms the thought of the unity of all Nature and of the continuous development of her forms, on grounds not of pure speculation, but of observation and reflection upon it. Darwin's corresponding conclusions also originated from the simplest observations that presupposed no scientific

character, and were open to be made, with a little tact, by every sharp eye and clear head. The English can also furnish us with the model for this participation of unprofessional persons in the observation of Nature. Not only their many colonies, their residencies, and their domains, in the farthest parts of the globe, permit individuals to make numerous new and valuable observations, but there are also in England numbers of wealthy persons who, having no official positions, are animated by a spontaneous scientific enthusiasm, and are able to come forth again and again as patrons of scientific researches. Thus the gap between amateurs and professionals in the sciences is necessarily becoming narrower. The closer relation of the world of students to the public must, on the other side, give heart to the individual—yes, raise up a positive desire in him to make known what he has observed, and inspire him to experiments of his own. Community in work of this kind can already show its results. A perusal of the journal "Nature," in which students and laymen publish their researches and observations from the fields of science in all the five quarters of the globe, wherever Englishmen dwell, will illustrate this in the plainest manner. Inquiry is active, then, and is stimulated by the constant contribution of new facts. The most distinguished men of science are not ashamed to take part in these proceedings; but their communications give the nation opportunity to become immediately acquainted with their researches, to estimate their value, and rejoice over the good that accrues to the nation from them. In Germany such a usage could, in consequence of the closer relations of the different members of society, be made to be of much wider significance than in England. —*Translated for the Popular Science Monthly from "Humboldt."*

FOOD AND FIBER PLANTS OF THE NORTH AMERICAN INDIANS.

By J. S. NEWBERRY.

IT has happened to me to visit nearly forty tribes of the native population of North America, and many of these at a time when they had had little or no intercourse with the whites. As a physician and botanist, my attention was naturally directed to the use of plants among them for food, and as remedies. I made many notes on these subjects, and, as they have never been published, and contain some items that may be interesting, it has seemed to me worth while to put them on record. Most of the observations to which I have referred were made a quarter of a century ago among the Indians of the Far West, remote from civilization, and where they were living in the "state of nature." The plants, of which the Indians I have visited have made use, are the following:

1. Maize (*Zea mais*), our Indian corn, seems to have been the most widely diffused and most important of all the kinds of vegetable food employed by the native population. In all parts of North and South America, where the climate was favorable, the whites found corn cultivated by the aborigines, and in the tombs of Peru as well as in the mounds of the mound-builders, ears of corn have been discovered, which prove that it was an important element of subsistence as far back as human records extend. Even the nomadic Indians who inhabited the forest-covered region between the Mississippi and Atlantic had their corn-fields and their patches of beans and squashes, and succotash (the Indian name) was the dish most esteemed in their *cuisine*, and is almost the only one which has been adopted by the whites.

In the region west of the Mississippi only a limited district is adapted to the cultivation of maize. It is a plant which finishes its growth and ripens its seed within three or four months, and it therefore matures within the tropical summer which prevails even to the northern boundary of the United States. But it requires both warmth and moisture; hence in the dry regions of the Far West it can only be cultivated in few localities, and there attains but imperfect development. In California, where so many fruits, flowers, and grains reach unequaled perfection, the cultivation of corn is rarely successful. Even where irrigation supplies the necessary moisture and the midday sun is hotter than in any Eastern State, the cloudless sky permits such rapid radiation that the nights are always cool, often cold, and the warm, moist nights of midsummer in the Mississippi Valley, when the corn may be heard to grow, never occur. On the table-lands of Arizona, New Mexico, and Mexico corn is quite extensively cultivated, but under difficulties, and never with what we should call success. The plant is always small, the grain light in texture and usually of some fancy color, and it is not uncommon to see the bread or cakes baked from it of a positive blue. Among the Moquis of Northeastern Arizona, where the plains that are cultivated are sandy, the seed-corn is dropped to the bottom of holes twelve to fifteen inches deep, made with a stick. Though dry at the surface, the sand is moist below, having absorbed all the water furnished by the snows of winter, and the cloudless sun warms the soil so that the grains germinate even at that depth. When the growing plant rises above the surface of the ground it immediately shoots out its ears, and the field when the crops mature looks as though it had been inundated and sand deposited around the stems to half their height. The color of the grain is usually blue, and the bread made from it and baked between two flat, smooth stones by the Moquis, though well flavored, looks like blue wrapping-paper.

2. Beans (*Phaseolus vulgaris*). It has been demonstrated that one or several kinds of beans were generally cultivated in America at the time of the discovery by Columbus. The "Lima-bean" was certainly

unknown in Europe before it was received from America, and that is probably true of other varieties. Among the Pueblo Indians of the table-lands, and the Mohaves on the Colorado, we found many different kinds of beans in cultivation. Some of these were of excellent quality, more delicate in texture and flavor than any cultivated by the whites.

Among the Mexicans and the inhabitants of our Territories bordering on Mexico the *frijole* is the most important article of diet, and in all campaigns and exploring expeditions in the West our people have come to consider beans as the most useful element in the commissary department. In making forced marches where the least possible weight could be carried, two articles of food were chosen in preference to all others, viz., beans and coffee; if only one could be taken, that was always the bean, which possesses more and more varied nutritious elements than any other fruit or seed cultivated by man.

3. *Psoralea esculenta* (*pomme blanche*). The root of this leguminous plant has been for centuries an article of food among the Indians inhabiting the Rocky Mountains and the plains bordering them. It is frequently referred to by the earlier travelers in that region, and was sometimes their main subsistence during the intervals when for any reason game was not to be had, and transported supplies had been exhausted. The root is white and farinaceous, but has a negative flavor, and as it nowhere exists in great quantity, it has been rather a make-shift than a staple, and its use has been abandoned wherever the supplies furnished by the white man have been attainable. The plant is about a foot high, with hairy stems and leaves, and with compact spikes, of bluish-white flowers. The root is tuberous, an inch or more in diameter, white, farinaceous, and wholesome.

4. *Camassia esculenta* (*camass*). Over all the country drained by the Columbia River, and especially the plains and mountain valleys about its sources, the camass grows in considerable abundance, and it has been not only a common resource for the Indians inhabiting that region, but certain localities where it is found in large quantities have taken their names from it, and they are places of resort for the purpose of gathering it. One of these is the somewhat noted Camass prairie on the line of travel from the Upper Missouri to the Columbia. The plant is liliacious, has linear leaves, a scape usually twelve to eighteen inches in height, bearing pretty blue or white flowers. The bulb is about an inch in diameter, mucilaginous, sweetish, and quite nutritious. Where it abounds it is gathered in large quantities, baked, and stored for winter use.

5. *Peucedanum farinosum* (biscuit-root, couse). In the country bordering the Columbia and in Northern California there are many plants which belong to the umbelliferous genus *Peucedanum*, some with yellow and a few with white flowers. The foliage is much dissected, sometimes capillary like that of the fennel. Among these is

one which has a round or oblong, white, farinaceous root somewhat like a small parsnip. It is called couse, or biscuit-root, by the Oregon Indians, and is quite an important source of food among them. It is gathered and dried for winter use, is then ground between stones to a kind of flour, and of this a palatable and nutritious cake is made. It is also sometimes boiled with meat.

6. *Apios tuberosa* (ground-nut). In all the United States on or east of the Mississippi the twining stem and purple flowers of the ground-nut are well known to the country boys, for they have learned that at the base of that stem are tubers which may be eaten and with a little make-believe enjoyed. These tubers were quite as well known to the aboriginal inhabitants, and to them they were a more important article of food. They are, however, small, somewhat woody, and in all respects inferior to the potato, which superseded them wherever attainable.

7. *Helianthus tuberosus* (Jerusalem artichoke). This plant is usually supposed to have been introduced from Europe, but Dr. Gray has given good reasons for believing that it is a native of this country, and that its tubers were used by the Indians of the Mississippi Valley for food. It has been said to be a variety of *H. doronicoides*, but is probably a form of *H. giganteus*.

8. *Helianthus annuus* (sunflower). In the central part of the continent—Colorado, Utah, Idaho, and Wyoming—are large areas of open ground which sustain a vigorous growth of the sunflower. It is always an evidence of good soil where it grows, and the magnitude of the stem, which is often six or seven feet high, and the flowers four to five inches broad, measures the richness of that soil. Nowhere in nature do the flowers become so large and the seeds so abundant as in the cultivated variety, but the seeds have long been used for food by the Indians, and it is probable that the plant grew larger about their villages than we now find it in the dry and comparatively sterile regions of the Far West. The Indians use the seeds for food, and sometimes extract an oil from them which is employed for the hair, or to lubricate or paint the face or body.

9. *Wyethia robusta* (Nutt.). In Oregon and Northern California I found the Indians gathering the seeds of a species of *Wyethia*, which Dr. Gray considers that described by Nuttall. On the east side of the Sierra Nevada, several species of the genus are very widely distributed, the larger ones having flowers which resemble those of *Inula*, and in many dry regions for a brief interval in the spring the surface is quite covered with their broad ovate leaves, and the scene made brilliant by their showy golden flowers. Their glory is, however, short-lived, for early in the summer the flowers disappear, the leaves become dry and brown, and rustle under the feet like those which fall from the trees in our forests with the autumn frosts. The achenia of *Wyethia* are relatively large, and contain a sufficient amount of

albumen to afford considerable nutrition, but the chaff is quite in excess of the kernel, and, when bruised together in their rude mortars, the Indians are compelled to gorge quantities of the material to satisfy their hunger. It is poor food at best, but is a welcome resort when, as it often happens, they are on the verge of starvation.

10. NUT-PINES.—In various parts of the Far West grow species of *Pinus* in which the seeds are of unusual size. The primary object of this is undoubtedly to furnish an adequate amount of prepared food to the germinating plant in regions where the struggle for existence is desperate, not with competing forms of vegetable life, but against the sterility of the soil or the severity of the climate. Incidentally this provision of Nature is of great benefit to a variety of animals, and even to man himself. It is evident that this special device for securing the perpetuation of the species is vicarious with the development of the wing upon the seed by which it is caught in the wind and its distribution favored. Where the seed is unusually large and heavy the samara can do little for its transportation, and where it is largest the wing is reduced to a simple raphe, or has entirely disappeared. For the most part these nut-pines are the inhabitants of arid regions where the amount of animal life is small, and therefore there are few enemies by which the seed would be destroyed. And there the sterility is such that any device by which the seed was carried away from the protecting shade and the fertilizing influence of the parent tree would be destructive rather than protective. Hence the seeds are wingless, and are dropped among the decaying leaves that gather under and about it. To the Indians these pine-nuts are in some regions not only an important but almost an indispensable source of subsistence; they gather them systematically, as our farmers harvest their crops, and, in cases where for any reason a failure of this crop occurs, some tribes or bands have been brought nearly or quite to starvation for the want of the nutriment they afford.

The list of the nut-pines of the Far West includes the following species: *Pinus Sabiniana* and *P. Coulteri*, of California; *P. albicaulis* and *P. flexilis*, which grow on the mountains of Oregon, Idaho, Montana, etc.; *P. edulis* and its variety, *P. monophylla*, of the arid districts of Nevada, Utah, Arizona, and New Mexico; and, finally, *P. Parryana* and *P. cembroides*, of Lower California and Northern Mexico. Of these, *P. Sabiniana* has large, ovoid, massive cones, six to eight inches in length and four to six inches in diameter, of which the surface bristles with strong and curved spines. The seeds are as large as good-sized beans, and of much the same form. The tree grows to a moderate or large size, but never forms forests. It is generally found scattered over the rocky foot-hills of the mountains, up to the height of three or four thousand feet—its great spiny cones, its spreading form, and blue-green foliage, making it everywhere conspicuous.

Pinus Coulteri, which in many respects resembles the last, is more southern in its habit, occupying the mountains of California south of San Francisco. The cones are similar to those of *P. Sabiniana*, but much longer, often one foot in length by five or six inches in diameter, and having a conical form. The seeds are large, bean-shaped, and edible. Like those of all the nut-pines they have a strong terebinthine taste when raw, but this disappears when they are roasted, as they generally are by Indians and whites.

By far the most interesting and economically important of the nut-pines is the "Piñon" (*P. edulis*), which inhabits the almost desert portions of the Great Basin of Arizona, New Mexico, and Colorado. In some parts of Nevada and Utah its monophyllous variety occupies, with a sparse and scattered growth, large areas, where it is the only tree, except a bushy cedar (*Juniperus Utahensis*). In Arizona, New Mexico, and Southwestern Colorado, its normal or two-leaved form is everywhere present, sometimes forming what might be called a forest-growth, though the trees are never large nor closely set. In all these regions the wood of the "Piñon" is the chief dependence of the lead-smelters for fuel, since it is quite dense, and, unlike that of any other conifer, furnishes good charcoal. Equally valuable is this tree to the native population, from the subsistence afforded by its nuts. The cones are small and ovoid in form; the wingless seeds are elliptical in outline, half an inch in length, and very palatable when roasted. The tree is said to fruit abundantly but once in three years; different colonies, fortunately, having different periods, so that there is no year in which there is entire failure of the crop, except when one of the terrible droughts characteristic of the climate occurs.

At the season of the nut-harvest the natives migrate to the groves of "Piñon," and gather the nuts in large quantities to be stored for future use. They are treasured as their choicest delicacies; and a handful of pine-nuts is to an Indian child as much of a treat as are sugar-plums to our boys and girls. Some of the Piñon-groves on the flanks of the Sierra de la Plata in Southwestern Colorado have evidently been visited periodically by the Pueblo Indians for ages; for fragments of their peculiar ornamented pottery cover the ground; at least every square yard has its potsherd.

The seeds of *Pinus flexilis* and *P. albicaulis* are smaller than those already mentioned, and the trees are more Alpine in habit and scattered; the nuts have, therefore, comparatively little value to the Indians, but they are an all-important source of food to the squirrels which inhabit the regions where they grow.

The more southern nut-pines, *Pinus cembroides* and *P. Parryiana*, are similar in their habit to *P. edulis*, of which they are, indeed, probably varieties. Their seeds, like those of the Piñon, are used by the natives in the same way, and are only less important because the trees are more restricted in their range.

FRUIT OF THE CACTUS.—The prickly pears which grow on so many species of cactus, differ very much among themselves, but quite a large number are edible. The fruit of the giant cactus (*Cereus giganteus*) is in size, consistence, and flavor, somewhat like a fig. The plant sometimes grows to fifty feet in height, and flowers near the summit, and since it can not be climbed on account of the spines by which the trunk is thickly set, it is a matter of no little difficulty to get at the fruit when it ripens. The Indians beat it off with stones, if any chance to be near, and sometimes shoot it off with arrows.

The fruit of many other species of *Cereus* is eaten and is doubtless nutritious, but the flavor is usually insipid, and, however, attractive it may be, in the "eyes" which are scattered over the surface lurk many minute, sharp, and brittle needles, which will penetrate the tongue and lips, and cause great suffering to any one who bites it rashly. The natives are always careful to wipe or brush off these spines before the fruit is either handled or eaten.

The *Opuntias* (*palmate cactus*) include a great number of species differing considerably in size and habit. As among the other kinds of cactus, the fruit is usually brilliantly colored, has a smooth and spiny skin, and pulpy interior thickly set with seeds. Though generally somewhat tasteless, and sometimes having a disagreeable flavor, the fruit of certain species is esteemed by the Mexicans and Indians, and one species at least may be said to be cultivated for its fruit. This is the *Tuna*, the gigantic *Opuntia* of Chihuahua and Sonora. Around the old missions may be seen many of these plants, some of which are so large that the fruit is gathered by the help of ladders! Among all the prickly pears, however, the fruit of the strawberry cactus (*Cereus stramineus*) is the most delicious. It is ovoid in form, as large as the largest strawberry, of similar color and even finer flavor. It grows sparingly in New Mexico and Chihuahua, and the fruit is eagerly sought by men, birds, and insects; so that, being a shy bearer, the supply is decidedly behind the demand.

Dr. V. Harvard, United States Army, who has given us much interesting information in regard to the botany of the region bordering the Rio Grande, mentions several other species of cactus, of which the fruits are edible, viz., *Cereus dasyacanthus*, (Eng.), fruit sub-globose one inch in diameter, green or greenish-purple, when fully ripe delicious to eat, much like a gooseberry; and *Echinocactus longehamatus*, fruit one to two inches long, red, and as delicious as that of the strawberry cactus. Of these I have collected the plants, but have never seen the mature fruit.

Nuphar polysepala (Western water-lily). In Oregon our yellow water-lily (*Nuphar advena*) is represented by a species which resembles it in flower, leaf, and habit, but differs from it in having a larger number of sepals. The seed-pod is also larger, often having the size and form of an egg, and being filled with seeds which are not unlike

the grains of our broom-corn. They are well flavored and nutritious, and are locally much used by the Indians for food. One of the Klamath lakes, which is about ten miles in diameter, is very shallow, and a large part of the surface is covered with the leaves of this water-lily. The Indians who live upon the banks of this lake gather the capsules as they mature, and store them for winter use. In some of their wigwams we found as many as twenty or thirty bushels of them at the time of our visit in August. Just how they are used I can not say, but I believe they are either ground to make a kind of coarse flour, or are parched, as the grains of maize so frequently are by the Indians. Perhaps nowhere else does this plant furnish an important food-staple, but for many hundreds of the Klamath Indians it is one of the most valuable of their winter stores.

Acorns.—At least two kinds of oak in California furnish acorns which are used as food by the Indians (*Quercus lobata* and *Quercus agrifolia*). Of these, the first is the largest of Western oaks; it is found in the greatest perfection along the streams in the Sacramento valley, where I have sometimes seen it a hundred feet in height, and covering with its spreading branches a circle more than one hundred feet in diameter. The acorns are long—elliptical in outline, an inch and a half in length by half an inch or more in diameter. The kernel is sometimes rather bitter, but more palatable than that of any of our Eastern oaks, and quite nutritious. In the region where the tree abounds, the Indians in former times were in the habit of collecting acorns in large quantities and storing them for winter, and I have seen nearly a hundred bushels in one wigwam. They are prepared for eating by grinding the kernels to a kind of coarse flour; this is mixed with water to a thick paste; a circular depression with raised edges is made in the sand, into which this paste is poured. A fire is then built over it, and it is half-baked, half-steamed, to the Indian taste. This treatment takes the bitterness from the acorn, and the resulting cake, though according to our notions somewhat lacking in cleanliness, is well-flavored and wholesome.

In Southern California the evergreen-oak (*Q. agrifolia*) grows to be a magnificent tree, but throughout the broad region it inhabits it is more generally a small tree or even a large bush. Its acorns are long and pointed, sometimes quite acute; the kernel is somewhat bitter, but it is often used for food by the Indians who inhabit the more arid portions of the region where it is found, and where the scarcity of subsistence drives them to eat whatever is nutritious and not positively harmful.

The mezquite (*Prosopis glandulosa*) is one of the most widespread and useful plants in the southwestern portion of the United States and Northern Mexico. In Texas it is a tree of respectable size, the trunks attaining on the Brazos a diameter of a foot or more, but it is always low and spreading. In the more arid regions it sometimes

grows abundantly, but only as a bush. In such cases, however, the roots are of large size, of peculiarly dense texture, and furnish an excellent fuel. The fruit of the mesquite is a yellow, bean-like pod, six to eight inches in length, by one half an inch wide. In this there are numerous hard, dark seeds, and between them a considerable quantity of a yellow, farinaceous substance, sweet and agreeable to the taste. Where the tree abounds these pods are eaten by all herbivorous animals, and in certain localities they serve as subsistence for human beings. In the Mohave Valley, on the Colorado River, we found Indians making considerable use of the fruit of the mesquite for food. The pods were pounded together in a kind of rude mortar, the seeds and husks imperfectly separated, and the farinaceous substance made into a kind of cake. This closely resembled a preparation of yellow corn-meal, and tasted a little like it.

Nelumbium luteum (water-chinquapin). This beautiful plant is found in comparatively few localities, and it therefore can not be regarded as an important source of food-supply; but the filbert-like nuts which are contained in its discoid receptacles, and which have given it its common name, are eatable, and have always been valued by the Indians. The *Nelumbium* is most abundant in the western part of Lake Erie, especially about the mouth of the Maumee River. It also grows on the islands in that lake, in Lake Winnebago, in the Ohio at North Bend, Sodus Bay, New York, Seldon's Cove on the Connecticut, and in the Delaware. In many of these localities it is supposed to have been planted by the Indians. This is the finest of our North American water-lilies, and it may be at once recognized by its large peltate leaves, and its flowers, six inches in diameter, greenish-yellow in color, often with a flush of red.

Our plant is closely allied to *N. speciosum*, which grows spontaneously in India, and, like the papyrus, was formerly cultivated on the Nile, but is not now found in Egypt. This is sometimes called the lotus, but the true lotus was a *Nymphæa* (*N. lotus*), a species very much like our white water-lily (*N. odorota*).*

Wild rice (*Zizania aquatica*). This plant, though very widely

* Both the white water-lily, the true lotus, and a blue one (*Nymphæa cærulea*) grow abundantly in the delta of the Nile, and were highly esteemed by the flower-loving Egyptians. They were used by them to decorate the tables in their feasts, and as crowns and garlands for the guests. They also formed a conspicuous feature in their offerings to the gods, and at funeral ceremonies.

There is considerable difference of opinion among scholars as to the identity of the plant which bore the fruit said by Homer in the "Odyssey" to have been offered to Ulysses in North Africa, and reputed to have the peculiar property of making those who ate of it forget home and country. It certainly was not the Indian nor the Egyptian water-lily, for Herodotus has described them both; but it was probably the fruit of *Zizyphus lotus*, a small tree which grows in Barbary. This is something like a date or plum in appearance, has a delicious flavor, and the Arabian poets ascribe to it a lethal influence similar to that felt by Homer's *lotophagoi*.

distributed, is most abundant in the shallows of our chain of Great Lakes. In some places many thousand acres are occupied by it, and it resembles fields of grain. The stalk is often seven or eight feet in height, projecting four or five feet above the water. In the autumn, when the seeds are ripe, such localities are now thronged with water-fowl, which are very fond of it. In early days, while the Indians were numerous about the Great Lakes, the wild-rice harvest was an important epoch in their year. As usual, the labor of collecting the seed fell to the lot of the women. These, pushing their canoes into the thickest growth, bent the heavily-laden tassels down and beat off the seeds with sticks. In this way their boats were soon loaded, and the grain became their most important resource during the long winter that followed. The shores of the west end of Lake Erie are still occupied by the wild rice, just as in ancient times, for it grows where man can neither cultivate the soil nor navigate the water. Here, where it was gathered in greater quantities than anywhere else by the Indians, it still feeds great flocks of water-fowl, but not a human being. The grain is small, with great difficulty separated from its envelopes—is, in fact, a poor kind of oat, which was superseded by the wheat of the white man in the estimation of the Indian long before he took his departure to the happy hunting-grounds.

Mescal. The different species of *Agave* have played a most important part in the economy of the native population of Northern Mexico and our Southwestern Territories. From them they have obtained food which, though not to our taste, is in their estimation a luxury. They have also distilled from them intoxicating liquors which, for the time being, have made them happier than the food they ate, and from some of the species they have obtained fibers of great strength, of which they have made varied use. At least two species (*A. Parryi* and *A. Palmeri*) are known by the popular name *mescal* among the Indians and Mexicans. Of these the central bud from which the flower-stalk springs is, at certain seasons, charged with a sweet, gummy substance which is prepared beforehand to supply the rapid drain of material in the growth of the flower-scape, flowers, and fruit. When cut out at this time it looks somewhat like a small cabbage; this is roasted in the ashes, and is considered by some of the Indian tribes a great delicacy. It is very sweet, but is a mass of fibers, and I can only compare it to oakum dipped in molasses. Probably its sweetness commends it to those who get very little sugar in other forms. Sometimes this central bud when roasted is distilled, and furnishes a fiery kind of whisky, which is also known as *mescal*.

The maguey, or century-plant (*Agave Americana*), throughout Northern Mexico supplies both fermented and distilled liquors. It is sometimes cultivated for this purpose, but over large districts is so common as to be the most striking feature in the vegetation, and the demand is fully supplied from this spontaneous growth. The Indian

name of the liquor made from it is *pulque*, and the establishment where it is distilled is called a *pulqueria*.

Other species of *Agave*, which have narrower and less fleshy leaves, furnish neither food nor drink, but valuable fibers. Of these the most celebrated is the Sisal hemp (*Agave sisalana*), a tropical plant of which the home is in Southern Mexico. It furnishes a fiber similar to the Manila hemp, and of equal value. This plant will grow in Florida, and many years ago Dr. Perrine obtained a grant from the American Government to establish a plantation of it. He was in the full tide of successful experiment when the Seminole War broke out, and his plantation was destroyed by the Indians, from which he with his family made an almost miraculous escape.

Another less known but scarcely less valuable plant belonging to the same genus, is the "lechuguilla" (*Agave heteracantha*) of Chihuahua and the surrounding country. Of this the leaves are from a foot to eighteen inches in length, and grow in a tuft like those of the century-plant. Though separated with some difficulty from the parenchyma in which they are enveloped, the fibers that traverse the leaves are numerous and very strong and are largely used by the Mexicans for the manufacture of ropes, sacking, etc. When the proper machinery shall be invented for treating the plant, it is probable that this fiber will become an important article of commerce.

Though less valuable, the fibers contained in the leaves of the large species of yucca (*Yucca baccata*), which abounds in the same region with the lechuguilla, are, to some extent, utilized in the same way.

Among the fiber-plants used by the Indians I should mention one lichen (*Evernia sarmentosa*) which, though of little importance, is interesting as the only plant of this group, so far as I know, serving any useful purpose among the Indians. In certain localities among the mountains of Oregon the fir-forests are draped with the gray fiber of the *Evernia*, which there has much the aspect of the Spanish moss as it hangs from the live-oaks in our Southern States. In a few instances I have seen this fiber utilized by the Indian women, who twist it into rolls as large as the little finger, and then sew these together to make a kind of jacket similar to that which they much more frequently form of strips of rabbit-skin. These garments are not handsome, but are thick and warm, and do much to protect the wearers from the severity of the winter in the Northwest.

The Sotol (*Dasylirion Texanum*). In Southwestern Texas and in Chihuahua one of the most common and striking plants is the *sotol*, as it is called by the Mexicans. In its general habit it resembles the yuccas. Usually the trunk is very short, scarcely rising above the ground, and from its summit radiate a large number of linear leaves, which are about three feet in length by two inches wide at the base, tapering to a fine and flexible point. The sides are armed with strong recurved hooks, which make it very unpleasant to handle, and even to

touch. In the regions where it abounds the hemispheres formed by the radiating leaves—four or five feet in diameter and height—are conspicuous objects in the scenery over thousands of square miles; from which it will be seen that the supply of material afforded by this plant is practically inexhaustible. The part which is used is the summit of the trunk, composed of the closely imbricated and thickened bases of the leaves. This is an ovoid mass from six inches to one foot in diameter, which at all times, and particularly before the period of florescence, contains a large amount of farinaceous and saccharine matter. When fresh it is tender and well flavored, and in that form would keep one from starvation; but, when roasted, it is much better, and constitutes an excellent and delicate vegetable. In traveling through that country I have made a lunch on a fraction of one of these roasted heads with great satisfaction to myself. It is, however, not used for food, except in emergencies. The Comanches and Lipans, the aboriginal inhabitants of this region, when pursued, found an unfailing resource in the sotol, and it is certainly impossible to starve those who have access to it. The most important use made of the sotol is to manufacture from it a kind of whisky, which is known as *mescal*, but is quite different from the other kinds. This liquor is made in a very simple way. A small still is taken to some spring or water-course where the sotol abounds, and there rudely set up; the plant is then collected by cutting off the leaves with a *machete*, leaving a cabbage-like head. This is severed from the root, loaded onto donkeys, and brought to the *vinata*, or distillery, where it is roasted. This is effected in a pit four or five feet deep and ten or twelve feet in diameter, lined with blocks of stone at the sides and bottom. Fuel is heaped into this pit and fired; when the fire is burned out the pit is filled with the heads of sotol. In the course of a few hours they are somewhat irregularly roasted and steamed; they are then taken out, chopped in small pieces, thrown into vats, and allowed to reach vinous fermentation. The liquid extracted from the pomace is then distilled, making a white, peculiarly-flavored, but not disagreeable spirit, that is largely used in this region. Though less highly esteemed than the more carefully-made mescal distilled from the maguey, it is preferred to the whiskies made from corn or rye, and it is certainly much less injurious. It is reported that delirium tremens is unknown in the country where it is most used, and I saw among the people none of the usual effects of alcoholism either in their persons or manners. The country where the sotol abounds is capable of furnishing an unlimited quantity of alcohol, and it might, therefore, replace the grains which are sacrificed to its manufacture in the United States.

Soap-Plants.—*Chlorogalum pomeridianum* (Amole). In the valleys of California grows a tall, slender-stemmed liliaceous plant, with purple and white flowers, which played an important part in the economy of the Spanish population, and is still more or less used by

the country people. It is the well-known Amole, or soap-plant. It rises from a subterranean bulb, which is egg-shaped in form, two or three inches in diameter, and enveloped in a thick coating of black, matted, hair-like fibers. This bulb has the detergent properties of soap, cleaning the hands or clothing quite as well as and much more pleasantly than the coarser kinds of soap.

In Mexico and our Southwestern Territories there are several other soap-plants, of which the narrow-leaved yucca (*Y. angustifolia*) is the most famous, because of its wider distribution rather than its greater efficiency. Aside from baser uses it is generally employed by the Mexican women to wash their luxuriant and lustrous hair, of which the beauty is said to be largely due to this practice. The leaf pulp and the roots of the larger yucca (*Y. baccata*) have the same properties though to a less degree; but the most effective soap-plant of this region is the lechuguilla, of which the parenchyma of the leaves is thought by the inhabitants of the country where it grows to be better than the best soap for washing, and it is claimed that this portion of the leaf if dried and powdered may be made as useful an article of export as the fibers.

Still another and very different soap-plant is found in Texas and Mexico, the (soap-berry) *Sapindus marginatus* (Wild.). This is a tree twenty or thirty feet in height, which bears a multitude of whitish berries as large as small cherries, and which have a very mild and yet efficient detergent property.

Berries.—The Indians are great berry-eaters. During the summer the huckleberries, strawberries, blackberries, etc., contributed largely to the subsistence of the Indians who formerly lived in the Mississippi Valley and the Eastern States; and when the white population increased, and villages and towns came near enough to offer markets, the women depended largely upon their baskets of berries for the purchase of the muslin, calico, blankets, and trinkets that soon became necessary for their happiness.

In the Far West berries are a much more important element in the commissary of the Indians, probably because they are produced there in an abundance and variety unknown in any other part of the world. The service-berry (*Amelanchier Canadensis*) grows throughout nearly the entire wooded region west of the Mississippi, not as a tree, but as a shrub, which forms tufts or thickets that in some regions become storehouses of delicious food. The berry is black when ripe, ovoid in form, and often half an inch in length. It is very sweet, palatable, and nutritious, and no one need starve or suffer from hunger where it is plentiful. In places it covers mountain-slopes continuously for miles, and I have there seen thousands of acres thickly set with bushes six or eight feet high, fairly bending under the weight of fruit, which was drying up and decaying because there seemed neither insect, bird, animal, nor man to eat it.

In a great number of localities service-berries are stored for winter use by the Indians. They are gathered where most abundant, crushed and made into a paste which is spread out on bark or stones in the sun until it is thoroughly dried. It is then put in sacks, and during the winter serves to give variety to their diet which otherwise consists of flesh or dried fish.

Huckleberries.—As formerly among the Eastern Indians, so now among those of the Far West the huckleberry is not only a luxury but almost a necessity. The species in the two districts are not the same: in the East the high and low blueberries (*Vaccinium corymbosum* and *V. Pennsylvanicum*), and the black huckleberry (*Gaylussacia resinosa*), are the most useful kinds. In the West are many species, but only two which have economic importance. Of these, one is small, and resembles our *V. Pennsylvanicum*, but has a berry covered with bloom of a very pronounced blue color; the juice is very red and somewhat acid. This covers glades on the slopes of the Cascade Mountains, Oregon, and the fruit is so abundant as to give a bluish color to the whole suface; this I suppose to be *V. occidentalis* of Gray. Another species, which does not correspond to any description yet written, but may be a form of *V. Myrtillus*, surpasses in the excellence and abundance of its fruit any other huckleberry of which I have knowledge. It covers great areas on the flanks of the Cascade Mountains, in Oregon, where the forest has been burned off; growing two to four feet in height, and standing close on the ground; sometimes really bending under its load of berries. These are round, half an inch in diameter, of light wine-color, and of a delicious vinous flavor. So abundant is this fruit that, sitting down in a clump of these bushes, I have filled a quart cup without changing my position. The Indians make long journeys to the localities where these berries are most abundant and gather and dry them for winter use. The drying is rapidly effected by burning one of the great fir-trees which, killed by fire, have been subsequently prostrated by the wind and now lie thickly strewed over the open surfaces where the berries grow. When this is well burned and affords a steady heat, flat stones, if they can be found, are covered with crushed berries and set up before the fire where the drying is soon effected.

Several other berries that abound in the country bordering the Columbia are gathered and stored much in the same way. Of these, that which after the huckleberries and service-berries is most used is the salal (*Gaultheria shallon*). This plant is as unlike our Eastern wintergreen (*C. procumbens*), or the closely allied but acaulescent species of Oregon (*C. myrsinites*), as can well be imagined. It is a decumbent shrub, of which the stem is one to two feet long, the large ovate alternate leaves so thickly set as almost to touch their edges, and hanging below are a considerable number of black, pedunculate berries, growing in the axils of the leaves. These are larger and

longer than those of our wintergreen, are less aromatic, but well flavored. As the plant which bears them grows in the wooded districts so thickly set as almost to cover the ground, the quantity of fruit is very large, and it therefore becomes an important source of food to the Indians.

The small cranberry (*Vaccinium oxycoccus*), is found in the bogs of Oregon as well as those of Maine, and probably stretches quite across the continent. It is used by the Indians, but is nowhere abundant, and is therefore of little value to them.

One of the most noted fruits gathered by the Indians in the Northwest is the salmon-berry (*Rubus spectabilis*). The bush grows to the height of eight or ten feet, has handsome foliage, showy flowers, and a pinkish-yellow berry an inch in length, which resembles our Antwerp raspberry. It is wholesome and nutritious, and is largely used by both Indians and whites, but the taste is rather insipid, and it hardly justifies the promise of its beautiful appearance.

The Oregon grape—the fruit of two species of *Berberis* (*B. aquifolium* and *B. pinnata*)—affords agreeable variety to the diet of the Indians of the Northwest, and is sometimes eaten by the whites. The pretty yellow flowers, for which these plants are sometimes cultivated, are followed by clusters of deep-blue, bloom-covered berries which have a sharp yet pleasant acid taste; but they are small, and the quantity attainable in any locality is not large.

Throughout all the Rocky Mountain region the red-berried elder (*Sambucus racemosa*) grows as in the Eastern States and Europe, and makes its display of showy but useless berries. There, however, another species of the genus (*S. glauca*) has taken the place of the common elder (*S. Canadensis*) of the Eastern States. It is a larger plant than ours, and is sometimes loaded with black but very glaucous fruit, which is rather better than the fruit of *S. Canadensis* and is more used.

The buffalo-berry (*Shepherdia argentea*). Along the tributaries of the Missouri in Montana, of the Colorado in Utah, and San Juan in New Mexico, and in many other places throughout the Far West, may be found thickets of a somewhat spiny shrub ten to fifteen feet in height with peculiar glaucous, narrow, elliptical leaves resembling those of the olive. This shrub in July and August is sometimes loaded with bright-red pellucid berries which have the acidity and flavor of the red currant. These berries are much used and highly esteemed by the Indians and whites, affording a most agreeable change from ordinary camp-fare, and, by their acidity, supplying a physiological want to the system.

Another closely allied plant (*Eleganus argentea*), and more eastern in its habits, has a larger and edible though drier and less esteemed berry. Both these are close relatives of *Shepherdia Canadensis*, which grows throughout the Northern United States from New England to

Washington Territory, but which is a smaller and useless plant, easily distinguished by its ferruginous, scurfy leaves.

Gooseberries and Currants.—In the valley of the Mississippi and in the mountains of the Far West, a large number of species of *Ribes* are found which, for the most part would be called gooseberries, but among them at least one should be considered as a currant. Some of these plants are showy and interesting, but they are of very little utility. Several of them fruit abundantly, but the berries are insipid or even disagreeable to the taste. In the drier portions of Oregon and Northern California a species of *Ribes* is very abundant and a noticeable feature in the vegetation. It forms tufts or thickets which in the late summer are loaded with red and attractive fruit, but it is only a disappointment, the flavor being flat and insipid, so that it is never eaten by man. In the mountains of Utah I have seen a large and strong species bearing in great abundance a nearly smooth, purplish-brown berry. No small fruit could be more inviting, but it is never eaten; the taste is disagreeable, and the inhabitants have a conviction that it is poisonous.

Nuts.—The Indians of the Eastern States valued more highly, and gathered more abundantly than the whites have since done, the chestnuts, hickory-nuts, walnuts, and butternuts that are here so abundant. For these the Western Indians are compelled to content themselves with acorns and pine-nuts, for there are no chestnut nor hickory trees in all the Western country. The only nuts, indeed, to be found there are the chinquapin of Oregon (*Castanopsis chrysophylla*) and the *nogal* of Arizona, New Mexico, and Texas (*Juglans rupestris*), the latter a perfect "black walnut," but not larger than a boy's marble.

Pine-Bark.—One article of subsistence sometimes employed by the Indians is only resorted to when they are driven to great straits by hunger. Around many of the watering-places in the pine-forests of Oregon and California the trees of *Pinus ponderosa* may be seen stripped of their bark for a space of three or four feet near the base of the trunk. This has been accomplished by cutting with a hatchet a line around the tree as high up as one could conveniently reach, and another lower down, so that the bark, severed above and below, could be removed in strips. At certain seasons of the year a mucilaginous film (the liburnum) separates the bark from the wood of the trunk. Part of this film adheres to each surface and may be scraped off. The resulting mixture of mucilage-cells and half-formed wood is nutritious and not unpalatable, so that, as a last resort, it may be used as a defense against starvation. The frequency with which signs of its having been resorted to are met with is a striking indication of the uncertainties and irregularities of the supply department among savages.

SCIENCE AND REVELATION.*

By Professor G. G. STOKES, P.R.S.

ON the present anniversary, which is the conclusion of my first year of office as President of this Institute, I propose to address a few words to you bearing on the object of the Institute, and on the spirit in which, as I conceive, that object is best carried out.

The highest aim of physical science is, as far as may be possible, to refer observed phenomena to their proximate causes. I by no means say that this is the immediate, or even necessarily the ultimate, object of every physical investigation. Sometimes our object is to investigate facts, or to co-ordinate known facts, and endeavor to discover empirical laws. These are useful as far as they go, and *may* ultimately lead to the formation of theories which in the end so stand the test of what I may call cross-examination by Nature, that we become impressed with the conviction of their truth. Sometimes our object is the determination of numerical constants, with a view, it may be, to the practical application of science to the wants of life.

To illustrate what I am saying, allow me to refer to a very familiar example. From the earliest ages men must have observed the heavenly bodies. The great bulk of those brilliant points with which at night the sky is spangled when clouds permit of their being seen, retain the same relative positions night after night and year after year. But a few among them are seen to change their places relatively to the rest and to one another. The fact of this change is embodied in the very name, planet, by which these bodies are designated. I shall say nothing here about the establishment of the Copernican system: I shall assume that as known and admitted. The careful observations of astronomers on the apparent places, from time to time, of these wandering bodies among the fixed stars supplied us, in the first instance, with a wide basis of isolated facts. After a vast amount of labor, Kepler at last succeeded in discovering the three famous laws which go by his name. Here, then, we have the second stage; the vast assemblage of isolated facts are co-ordinated, and embraced in a few simple laws. As yet, however, we can not say that the idea of causation has entered in. But now Newton arises, and shows that the very same property of matter which causes an apple to fall to the earth, which causes our own bodies to press on the earth on which we stand, suffices to account for those laws which Kepler discovered—nay, more, those laws themselves are only very approximately true; and, when we consider the places of the planets, at times separated by a considerable interval, we are obliged to suppose that the elements of

* Presidential address delivered at the annual meeting of the Victoria Institute, on Tuesday, July 19, 1887.

their orbits have slowly undergone slight changes. But the simple law of universal gravitation, combined, of course, with the laws of motion, not only leads to Kepler's laws as a very close approximation to the actual motions, but also accounts for those slight changes which have just been mentioned as necessary to make Kepler's laws fit observation exactly. We are inevitably led to regard the attraction of gravitation as the *cause* which keeps the planets in their orbits.

But it may be said, What is the difference in the two cases? Is not the law of gravitation merely a simpler mode of expressing the observed facts of the planetary motions just like the somewhat less simple laws of Kepler? What right have we to introduce the idea of causation in the one case more than in the other?

The answer to this appears to be that in the one case, that of Kepler's laws, supposing them to be true, we have merely a statement of what, on that supposition, would be a fact regarding the motions of the planets, whereas in the other case the observed motions are referred to a property of matter of the operation of which in other and perfectly different phenomena we have independent evidence.

I have purposely omitted to mention the important difference between the two cases, which lies in the circumstance that Kepler's laws require correction to make them applicable to long intervals of time, whereas the law of gravitation shows no sign of failure; because, even if the former had been perfectly exact, however long the interval of time to which they were applied, I doubt if they would have carried with them the idea of causation.

To take another simple illustration, let us think of the propulsion of a bullet in an air-gun. We speak of the motion of the bullet as being *caused* by the elasticity of the compressed air. And the idea of causation comes in because we refer this particular instance of motion to a property of gas, of the existence and operation of which we have evidence in perfectly independent phenomena.

It is thus that in scientific investigation we endeavor to ascend from observed phenomena to their proximate causes; but, when we have arrived at these, the question presents itself, Can we in a similar manner regard these causes in turn as themselves the consequences of some cause stretching still further back in the chain of causation? If the motion of the bullet in an air-gun be caused by the elasticity of the compressed air, can we account for the elasticity of a gas? If the retention of the planets in their orbits be due to the attraction of gravitation, can we explain how it is that two material bodies should attract one another across the intervening space?

Till a time well on in the present century, we could only take the elasticity of gases as a fact, and deduce the consequences which flow from it. But the researches of Joule and Clausius and Maxwell and Crookes and others have accumulated so much evidence in favor of the general truth of the kinetic theory of gases, that we are now dis-

posed not to rest in the elasticity of gases as an ultimate property beyond which we can not go, but to regard it as itself a consequence of the molecular constitution of bodies, and of the motions and mutual collisions of the ultimate molecules of a gas. Respecting the attraction of gravitation we have not at present made a similar advance. Speculations, indeed, have not been wanting on the part of those who have endeavored to account for it. But none of these so fits into the known phenomena of Nature as to carry with it a conviction of its truth. Yet there is one indication that though we can not at present explain the cause of gravitation, yet it *may* be explicable by what are called second causes. The mass of a body is measured by its inertia; and, though we commonly think of a body of large mass as being heavy, and though we compare the masses of two bodies most easily and accurately through the intervention of weight, yet the idea of mass may be acquired, and means might easily be suggested by which the ratio of the masses of two bodies might be experimentally determined, without having recourse to gravitation at all. Now, according to the law of gravitation, the force with which a given body attracts another at a given distance is strictly proportional to the mass of the latter. If we suppose the attracting body to be the earth, and the attracted bodies to be in one case a brass weight, and in the other a piece of marble, it follows that if they make equilibrium when placed in the pans of a true balance—I make abstraction of the effect of the buoyancy of the air—their masses are strictly equal, and, accordingly, that weight is a true measure of mass. But there is no reason *a priori*, so far as with our present knowledge we can see, why this should be so. We know that if the bodies in the scale-pans were formed, one of brass and the other of iron, and there were a magnet concealed under the table on which the operator placed his balance, the masses would not be equal when there was equilibrium. But that the law is true, and that, accordingly, weight is a true measure of mass, follows with the highest probability from the third of Kepler's laws, and was proved experimentally by Newton, by experiments with pendulums. Newton's experiment has since been repeated by Bessel, with all the refinements of modern appliances, with the result that, so far as the most exact experiments enable us to decide, the law is strictly true. This is perhaps the only instance, as Sir William Thomson remarked to me in conversation, in which there is an exact agreement between two quantities, and yet we are unable to give any reason why they should agree. That such is the case, holds out some prospect of scientific men being able some day to explain gravitation itself—that is, to explain it as the result of some still higher law.

Such is the nature of our progress in scientific investigation. We collect facts; we endeavor to co-ordinate them and ascertain the laws which bind them together; we endeavor to refer these laws to their proximate causes, and to proceed step by step upward in the chain of

causation. Presently we arrive at a stage at which, even after long trial, we do not see our way to going further. Yet we are not able to demonstrate that further progress in the same direction—that is, along the chain of secondary causation—is impossible. Science conducts us to a void which she can not fill.

It is on other grounds that we are led to believe in a Being who is the Author of Nature. A conclusion so important to mankind in general is not left to be established as the result of investigations which few have the leisure and ability to carry out. Doubtless, where it is accepted, the study of science enlarges our ideas respecting the greatness of that Being, and tends to keep in check notions of too anthropomorphic a character which we might form concerning him. Still, the subject-matter of scientific study is not, at least directly, theistic, and there have not been wanting a few instances of eminent scientists who not merely rejected Christianity, but apparently did not even believe in the being of a God.

The religious man, on the other hand, who knows little or nothing of science, is in the habit of contemplating the order of Nature not merely as the work of God, but in very great measure as his *direct* work. Of course, the concerns of every-day life present innumerable instances of the sequence of cause and effect; and few are now so ignorant of the very elements of science as not to allow that the sequence of day and night, of summer and winter, is proximately due to the rotation of the earth about its axis, and the oblique position of that axis with reference to the plane of the earth's orbit. But when we get beyond the region of what is familiarly known, still more when we get outside the limits of well-ascertained scientific conclusions, and enter a region which is still debatable ground, where men of science are attempting to push forward, and are framing hypotheses with a view to the ultimate establishment of a theory in case those hypotheses should stand the test of thorough examination—when, I say, we get into this region, a man such as I have supposed may feel as if the scientists who were attempting to explore it were treading on holy ground; he may mentally charge them with irreverence; perhaps he may openly speak of them in a manner which implies that he attributes to them an intention to oppose revealed religion.

To take a particular example. I can imagine that a man such as I have supposed may have always been in the habit of regarding each one of the thousands and tens of thousands of species into which naturalists have divided the animal and vegetable kingdoms as having originated in an independent creative act; that the supposition may have become entwined among his religious beliefs. Such a man would be apprehensive of any attempt to introduce second causes in explanation of the observed fact of the great multiplicity of species.

Akin to the feeling which I have attempted to describe is another, against which we must be on our guard. The religious man is strong-

ly impressed with the truth of certain things which lie outside the discoveries of reason or the investigations of science, and which bear on the whole conduct of his life here, and on his hopes regarding life hereafter. He believes these truths to be divine, and, accordingly, that no legitimate deduction of human reason is liable to come in conflict with them. But the precise mode in which a conviction of the truth of these things was arrived at depends, to a considerable extent, on each man's idiosyncrasy. His natural bent of mind, his early training, his later associations, have all a good deal to do with it. Divine truth is one thing; our own apprehension of it, and the steps by which in our own minds it has been arrived at, are another. These are liable to human imperfection, and we may not attribute to them the infallibility which belongs to that which is divine. We are not to confound the scaffolding with the building; nor, if we are anxious for the safety of the edifice, need we therefore fear that, if the scaffolding were tampered with, the whole might come tumbling down, nor should we regard as a dynamiter a fellow-workman who would remove a pole or two.

That truth must be self-consistent, come from where it may, is an axiom which nobody would dispute; the only question can be, What is truth? Now, there are truths which we know by intuition, such as the axioms of mathematics; and there are others, again, which, though we do not perceive them by intuition, yet demonstrably follow from what we do so perceive; such, for example, are the propositions of mathematics. Then there are other conclusions which we accept as the result of the application of our reason to a study of Nature. Here the evidence is not demonstrative, and the conclusion may have all degrees of support, from such overwhelming evidence as that on which we accept universal gravitation, to what hardly raises the conclusion above the rank of a conjecture. On the other hand, there are conclusions which we accept on totally different grounds; namely, because we think that they have been revealed. Why we accept a revelation at all, is a very wide question which I can not here enter into. That we do accept it is implied in the membership of this Institute. But, granting the acceptance of revelation, the question remains, What and how much is involved in revelation? That is a question respecting which there are differences of opinion among those who frankly accept a revelation, and with it the supernatural.

Now, the primary object of the establishment of the Victoria Institute was to examine the questions as to which there was a *prima facie* appearance of conflict between the conclusions of science and the teachings of revelation. In order that such examination may be usefully carried out, it must be undertaken in a thoroughly impartial spirit, with a readiness honestly to follow truth wherever it may lead. It will not do to assume that the immunity from error which belongs to the divine belongs also to our apprehension of what constitutes the

divine, and that therefore, if a conflict there be, the error must be on the side of science. It is true that many statements, which are really little more than scientific conjectures, are represented, at least by those who take their science at second or third hand, as if they were the well-established conclusions of science. But it is true also that the progress of science has corrected the assertions of a crude theology. We are disposed nowadays to smile at the idea of any opposition between the Copernican system and the teaching of revelation; but we need not go back to the days of the persecution of Galileo to find an example of a well-supported scientific conclusion having met with a similar opposition, issuing in a similar result.

To gauge thoroughly the amount of evidence on which an asserted scientific conclusion rests, one ought to be well acquainted with the branch of science to which it relates. Still, one can get a fair general notion of the evidence by an amount of reading which is by no means prohibitive, or by conversing with those who have made that branch a special study. It may be that the impression thus left on the mind will be that the votaries of science, carried away by an excess of zeal in the attempt to discover the causes of natural phenomena, have really, though honestly, overestimated the evidence. It may be, on the other hand, that the inquirer will perceive the evidence to be weighty and substantial, in which case it behooves him to reconsider the supposition with which he started, that the conclusion was opposed to the teaching of revelation.

One should always bear in mind the great responsibility one incurs, and the mischief one may do, by representing as bound up with revelation that which really forms no part of it. Being by hypothesis no part of it, but only erroneously tacked on to it, it may be false, and, being false, it may be in opposition to a conclusion supported by the weightiest evidence, it matters not of what kind, but say scientific. What, then, will be the effect of the error committed by the upholder of revelation? The educated man of science may see through the fallacy; but will it not put a weapon into the hands of the infidel lecturer wherewith to attack revealed religion?

But whether we can agree or can not agree with the conclusions at which the scientific investigator may have arrived, let us, above all things, beware of imputing evil motives to him; of charging him with adopting his conclusions for the purpose of opposing what is revealed. Scientific investigation is eminently truthful. The investigator may be wrong, but it does not follow that he is other than truth-loving. If on some subjects which we deem of the highest importance he does not agree with us—and yet it may be he agrees with us more than we suppose—let us, remembering our own imperfections, both of understanding and of practice, bear in mind that caution of the Apostle: "Who art thou that judgest another man's servant? To his own master he standeth or falleth."—*Nature.*

ASTRONOMY WITH AN OPERA-GLASS.

THE STARS OF AUTUMN.

By GARRETT P. SERVISS.

IN the "Fifth Evening" of that delightful, old, out-of-date book of Fontenelle's, on the "Plurality of Worlds," the Astronomer and the Marchioness, who have been making a wonderful pilgrimage through the heavens during their evening strolls in the park, come at last to the starry systems beyond the "solar vortex," and the Marchioness experiences a lively impatience to know what the fixed stars shall turn out to be, for the Astronomer has sharpened her appetite for marvels.

"Tell me," says she, eagerly, "are they, too, inhabited like the planets, or are they not peopled? In short, what can we make of them?"

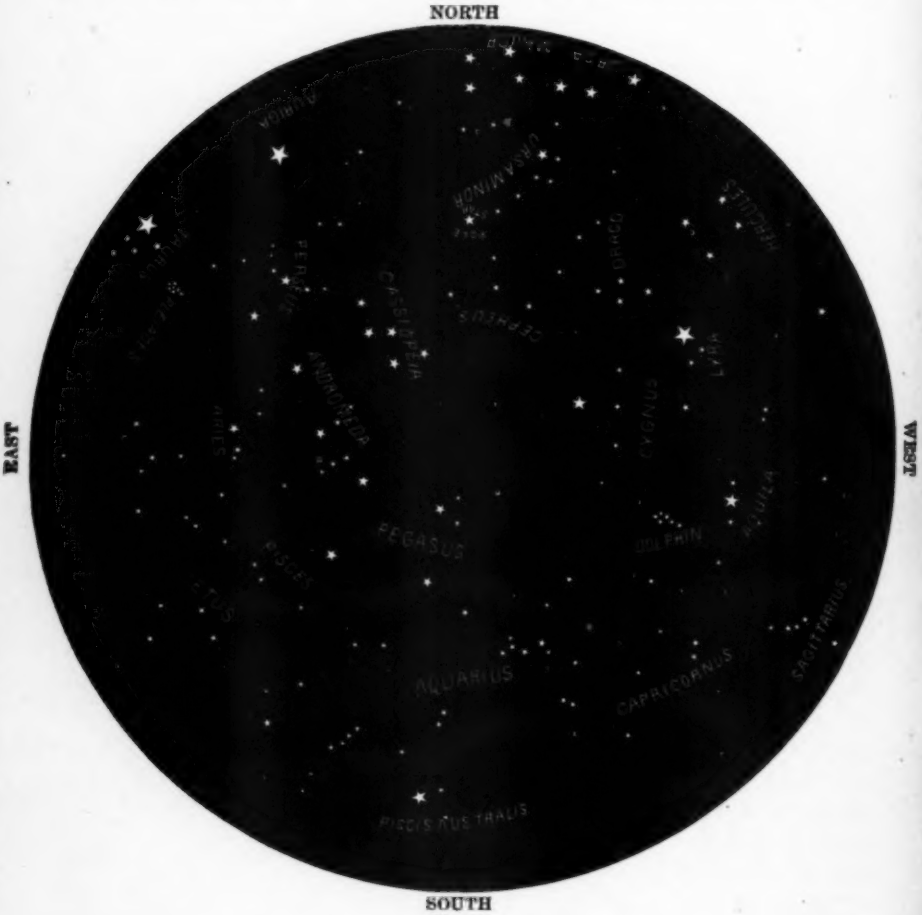
The Astronomer answers his charming questioner, as we should do to-day, that the fixed stars are so many suns. And he adds to this information a great deal of entertaining talk about the planets that may be supposed to circle around these distant suns, interspersing his conversation with explanations of "vortexes," and many quaint conceits, in which he is helped out by the ready wit of the Marchioness.

Finally, the impressionable mind of the Marchioness is overwhelmed by the grandeur of the scenes that the Astronomer opens to her view, her head swims, infinity oppresses her, and she cries for mercy.

"You show me," she exclaims, "a perspective so interminably long that the eye can not see the end of it. I see plainly the inhabitants of the earth; then you cause me to perceive those of the moon and of the other planets belonging to our vortex (system), quite clearly, yet not so distinct as those of the earth. After them come the inhabitants of planets in the other vortexes. I confess, they seem to me hidden deep in the background, and, however hard I try, I can barely glimpse them at all. In truth, are they not almost annihilated by the very expression which you are obliged to use in speaking of them? You have to call them inhabitants of one of the planets contained in one out of the infinity of vortexes. Surely we ourselves, to whom the same expression applies, are almost lost among so many millions of worlds. For my part, the earth begins to appear so frightfully little to me that henceforth I shall hardly consider any object worthy of eager pursuit. Assuredly, people who seek so earnestly their own aggrandizement, who lay schemes upon schemes, and give themselves so much trouble, know nothing of the vortexes! I am sure my increase of knowledge will redound to the credit of my idleness, and when

people reproach me with indolence I shall reply: 'Ah! if you but knew the history of the fixed stars!'"

It is certainly true that a contemplation of the unthinkable vastness of the universe, in the midst of which we dwell upon a speck illuminated by a spark, is calculated to make all terrestrial affairs appear contemptibly insignificant. We can not wonder that men for ages regarded the earth as the center, and the heavens with their lights as tributary to it, for to have thought otherwise, in those times, would have been to see things from the point of view of a superior intelligence. It has taken a vast amount of experience and knowledge to



Map 1.

convince men of the parvitude of themselves and their belongings. So, in all ages they have applied a terrestrial measure to the universe, and imagined they could behold human affairs reflected in the heavens and human interests setting the gods together by the ears.

This is clearly shown in the story of the constellations. The tre-

mendous truth that on a starry night we look, in every direction, into an almost endless vista of suns beyond suns and systems upon systems, was too overwhelming for comprehension by the inventors of the constellations. So they amused themselves, like imaginative children, as they were, by tracing the outlines of men and beasts formed by those pretty lights, the stars. They turned the starry heavens into a scroll filled with pictured stories of mythology. Four of the constellations with which we are going to deal in this article are particularly interesting on this account. They preserve in the stars, more lasting than parchment or stone, one of the oldest and most pleasing of all the romantic stories that have amused and inspired the minds of men —the story of Perseus and Andromeda—a better story than any that modern novelists have invented. The four constellations to which I have referred bear the names of Andromeda, Perseus, Cassiopeia, and Cepheus, and are sometimes called, collectively, the Royal Family. In the autumn they occupy a conspicuous position in the sky, forming a group that remains unrivaled until the rising of Orion with his imperial *cortége*. The reader will find them in our circular map, occupying the northeastern quarter of the heavens.

This map represents the visible heavens at about midnight on September 1st, ten o'clock P. M. on October 1st, and eight o'clock P. M. on November 1st. At this time the constellations that were near the meridian in summer will be found sinking in the west, Hercules being low in the northwest, with the brilliant Lyra and the head of Draco suspended above it; Aquila, "the eagle of the winds," soars high in the southwest; while the Cross of Cygnus is just west of the zenith; and Sagittarius, with its wealth of star-dust, is disappearing under the horizon in the southwest.

Far down in the south the observer catches the gleam of a bright lone star of the first magnitude, though not one of the largest of that class. It is Fomalhaut, in the mouth of the Southern Fish, Piscis Australis. A slight reddish tint will be perceived in the light of this beautiful star whose brilliancy is enhanced by the fact that it shines without a rival in that region of the sky. Fomalhaut is one of the important "nautical stars," and its position was long ago carefully computed for the benefit of mariners. The constellation of Piscis Australis, which will be found in our second map, does not possess much to interest us except its brilliant leading star. In consulting Map 2, the observer is supposed to be facing south, or slightly west of south, and he must remember that the upper part of the map reaches nearly to the zenith, while at the bottom it extends down to the horizon.

To the right, or west, of Fomalhaut, and higher up, is the constellation of Capricornus, very interesting on many accounts, though by no means a striking constellation to the unassisted eye. The stars Alpha (α), called Giedi, and Beta (β), called Dabih, will be readily

recognized, and a keen eye will perceive that Alpha really consists of two stars. They are about six minutes of arc apart, and are of the third and the fourth magnitude respectively. These stars, which to the naked eye appear almost blended into one, really have no physical connection with each other, and are slowly drifting apart. The ancient astronomers make no mention of Giedi being composed of two stars, and the reason is plain, when it is known that in the time of Hippar-

MAP 2.

chus, as Flammarion has pointed out, their distance apart was not more than two thirds as great as it is at present, so that the naked eye would not have detected the fact that there were two of them; and it was not until the seventeenth century that they got far enough asunder to begin to be separated by eyes of unusual power. With

an ordinary opera-glass they are thrown well apart, and present a very pretty sight. The star Beta, or Dabih, is also a double star with a glass magnifying five or six times, the smaller star being of the seventh magnitude and sky-blue in color.

The star Rho (ρ) is a double that will severely test your glass, and it is useless to undertake to see the companion unless your magnifying power is as much as six times, and the glass of excellent quality.

With the most powerful glass at your disposal, sweep from the star Zeta (ζ) eastward a distance somewhat greater than that separating Alpha and Beta, and you will find a fifth-magnitude star beside a little nebulous spot. This is the cluster known as M 30, one of those sun-swarms that overwhelm the mind of the contemplative observer with astonishment, and especially remarkable in this case for the apparent vacancy of the heavens immediately surrounding the cluster, as if all the stars in that neighborhood had been drawn into the great assemblage, leaving a void around it. Of course, with the instrument that our observer is supposed to be using, merely the *existence* of this solar throng can be detected ; but, if he sees that it is there, he may be led to provide himself with a telescope capable of revealing its glories.

Admiral Smyth remarks that "although Capricorn is not a striking object, it has been the very pet of all constellations with astrologers," and he quotes from an old almanac of the year 1386 that "whoso is borne in Capcorn schal be ryche and wel lufyd." The mythological account of the constellation is that it represents the goat into which Pan was turned in order to escape from the giant Typhon, who once on a time scared all the gods out of their wits, and caused them to change themselves into animals, even Jupiter assuming the form of a ram. According to some authorities, Piscis Australis represents the fish into which Venus changed herself on that interesting occasion.

Directly above Piscis Australis, and to the east or left of Capricorn, the map shows the constellation of Aquarius, or the Water-Bearer. Some say this represents Ganymede, the cup-bearer of the gods. It is represented in old star-maps by the figure of a young man pouring water from an urn. The star Alpha (α) marks his right shoulder, and Beta (β) his left, and Gamma (γ), Zeta (ζ), Eta (η), and Pi (π) indicate his right hand and the urn. From this group a current of small stars will be recognized, sweeping downward with a curve toward the east, and ending at Fomalhaut ; this represents the water poured from the urn, which the Southern Fish appears to be drinking. It is worthy of remark, that in Greek, Latin, and Arabic this constellation bears names all of which signify "a man pouring water." The ancient Egyptians imagined that the setting of Aquarius caused the rising of the Nile, as he sank his huge urn in the water to fill it. Alpha Aquarii was called by the Arabs Sadalmelik, which is interpreted to mean the "king's lucky star," but whether it proved itself a lucky star in war or in love, and what particular king enjoyed its benign in-

fluence and recorded his gratitude in its name, we are not informed. Thus, at every step, we find how shreds of history and bits of superstition are entangled among the stars. Surely, humanity has reflected itself in the heavens, at least as lastingly as it has impressed itself upon the earth.

Starting from the group of stars just described as making the Water-Bearer's urn, follow with a glass the winding stream of small stars that represents the water. Several very pretty and striking assemblages of stars will be encountered in its course. The star Tau (τ) is double and presents a beautiful contrast of color, one star being white and the other reddish-orange—two solar systems, it may be, apparently neighbors as seen from the earth, though really enormously far apart, in one of which daylight is white and in the other red!

Point a good glass upon the star marked Nu (ν), and you will see, somewhat less than a degree and a half to the west of it, what appears to be a faint star of between the seventh and eighth magnitudes. You will have to look sharp to see it. It is with your mind's eye that you must gaze, in order to perceive the wonder here hidden in the depths of space. That faint speck is a nebula, unrivaled for interest by many of the larger and more conspicuous objects of that kind. Lord Rosse's great telescope has shown that in form it resembles the planet Saturn; in other words, that it consists apparently of a ball surrounded by a ring. But the spectroscope proves that it is a gaseous mass, and the micrometer—supposing its distance to be equal to that of the stars, and we have no reason to think it less—that it must be large enough to fill the whole space included within the orbit of Neptune! Here, then, as has been said, we seem to behold a genesis in the heavens. If Laplace's nebular hypothesis, or any of the modifications of that hypothesis, represents the process of formation of a solar system, then we may fairly conclude that such a process is now actually in operation in this nebula in Aquarius, where a vast ring of nebulous matter appears to have separated off from the spherical mass within it. This may not be the true explanation of what we see there, but, whatever the explanation may be, there can be no question of the high significance of this nebula, whose form proclaims unmistakably the operation of great metamorphic forces there. Of course, with his insignificant optical means, our observer can see nothing of the strange form of this object, the detection of which requires the aid of the most powerful telescopes, but it is much to know where this unfinished creation lies, and to see it, even though diminished by distance to a mere speck of light.

Turn your glass upon the star shown in the map just above Mu (μ) and Epsilon (ϵ). You will find an attractive arrangement of small stars in its neighborhood. The star marked 104 is double to the naked eye, and the row of stars below it is well worth looking at. The star Delta (δ) is interesting, because, in 1756, Tobias Mayer narrowly escaped making a discovery there that would have anticipated that

which a quarter of a century later made the name of Sir William Herschel world-renowned. The planet Uranus passed near Delta in 1756, and Tobias Mayer saw it, but it moved so slowly that he took it for a fixed star, never suspecting that his eyes had rested upon a member of the solar system whose existence was, up to that time, unknown to the inhabitants of Adam's planet.

Above Aquarius you will find the constellation Pegasus. It is conspicuously marked by four stars of about the second magnitude, which shine at the corners of a large square, called the Great Square of Pegasus. This figure is some fifteen degrees square, and at once attracts the eye, there being few stars visible within the quadrilateral, and no large ones in the immediate neighborhood to distract attention from it. One of the four stars, however, as will be seen by consulting Map 2, does not belong to Pegasus, but to the constellation Andromeda. Mythologically, this constellation represents the celebrated winged horse of antiquity :

> " Now heaven his further wandering flight confines,
> Where, splendid with his numerous stars, he shines."

The star Alpha (α) is called Markab ; Beta (β) is Scheat, and Gamma (γ) is Algenib ; the fourth star in the square, belonging to Andromeda, is called Alpheratz. Although Pegasus presents a striking appearance to the unassisted eye, on account of its great square, it contains little to attract the observer with an opera-glass. It will prove interesting, however, to sweep with the glass carefully over the space within the square, which is comparatively barren to the naked eye, but in which many small stars will be revealed, of whose existence the naked-eye observer would be unaware. The star marked Pi (π) is an interesting double, which can be separated by a good eye without artificial aid, and which, with an opera-glass, presents a fine appearance.

And now we come to our third little map, representing the constellations Cetus, Pisces, Aries, and the Triangles. In consulting it the observer is supposed to face the southeast. Cetus is a very large constellation, and from the peculiar conformation of its principal stars it can be readily recognized. The head is to the east, the star Alpha (α), called Menkar, being in the nose of this imaginary monster of the sky-depths. This constellation is supposed to represent the monster that was sent, according to the fable, by Neptune to devour the fair Andromeda, but whose bloodthirsty design was happily and gallantly frustrated by Perseus, as we shall learn from starry mythology farther on.

By far the most interesting object in Cetus is the star Mira, marked Omicron (o) in the map. This is a famous variable star—a sun that sometimes shines a thousand times more brilliantly than at others ! It changes from the second magnitude to the ninth or tenth, its period

from maximum to maximum being about eleven months. During about five months of that time it is completely invisible to the naked eye; then it begins to appear again, slowly increasing in brightness for some three months, until it shines as a star of the second magnitude, being then as bright as if not brighter than the most brilliant stars in the constellation. It retains this brilliancy for about two weeks, and

MAP 3.

then begins to fade again, and, in about three months, once more disappears. There are various irregularities in its changes, which render its exact period somewhat uncertain, and it does not always attain the same degree of brightness at its maximum. For instance, in 1779, Mira was almost equal in brilliancy to a first-magnitude star, but frequently at its greatest brightness it is hardly equal to an ordinary star of the second magnitude. Mira will attain its greatest brilliancy about the 2d of November, this year. By the aid of our little map you will readily be able to find it. You will perceive that it has a

slightly reddish tint. Watch it during the coming winter, and you will see it gradually fade from sight until, at last, only the blackness of the empty sky appears where, a few months before, a conspicuous and brilliant star was seen. Keep watch of that spot next summer, and in July you will perceive Mira shining there again—a mere speck, but slowly brightening—and next fall the wonderful star will blaze out again with renewed splendor.

Knowing that our own sun is a variable star—though variable only to a slight degree, its variability being due to the spots that appear upon its surface in a period of about eleven years—we possess some light that may be cast upon the mystery of Mira's variations. It seems not improbable that, in the case of Mira, the surface of the star at the maximum of spottedness is covered to an enormously greater extent than occurs during our own sun-spot maxima, so that the light of the star, instead of being merely dimmed to an almost imperceptible extent, as with our sun, is almost blotted out. When the star blazes with unwonted splendor, as in 1779, we may fairly assume that the pent-up forces of this perishing sun have burst forth, as in a desperate struggle against extinction. But nothing can prevail against the slow, remorseless, resistless progress of that obscuration, which comes from the leaking away of the solar heat, and which constitutes what we may call the death of a sun. And that word seems peculiarly appropriate to describe the end of a body which, during its period of visible existence, not only presents the highest type of physical activity, but is the parent and supporter of all forms of life upon the planets that surround it.

We might even go so far as to say that possibly Mira presents to us an example of what our sun will be in the course of time, as the dead and barren moon shows us, as in a magician's glass, the approaching fate of the earth. Fortunately, human life is a mere span in comparison with the æons of cosmic existence, and so we need have no fear that either we or our descendants for thousands of generations shall have to play the tragic *rôle* of Campbell's "Last Man," or be induced to keep up a stout heart amid the crash of time by ungenerously boasting to the perishing sun, whose rays had nurtured us, that, though his proud race is ended, we have confident anticipations of immortality. I trust that, when man makes his exit from this terrestrial stage, it will not be in the contemptible act of thus kicking a fallen benefactor.

There are several other variable stars in Cetus, but none possessing much interest for us. The observer should look at the group of stars in the head, where he will find some interesting combinations, and also at the star Chi, which is the little star shown in the map near Zeta (ζ). This is a double that will serve as a very good test of eye and instrument, the smaller companion-star being of only seven and a half magnitude.

Directly above Cetus is the long, straggling constellation of Pisces, the Fishes. The Northern Fish is represented by the group of stars near Andromeda and the Triangles. A long band or ribbon, supposed to bind the fish together, trends thence first southeast and then west until its joins a group of stars under Pegasus, which represents the Western Fish, not to be confounded with the Southern Fish described near the beginning of this article, which is a separate constellation. Fable has, however, somewhat confounded these fishes; for while, as I have remarked above, the Southern Fish is said to represent Venus after she had turned herself into a fish to escape from the giant Typhon, the two fishes of the constellation we are now dealing with are also fabled to represent Venus and her interesting son Cupid under the same disguise assumed on the same occasion. If Typhon, however, was so great a brute that even Cupid's arrows were of no avail against him, we should, perhaps, excuse mythology for duplicating the record of so wondrous an event.

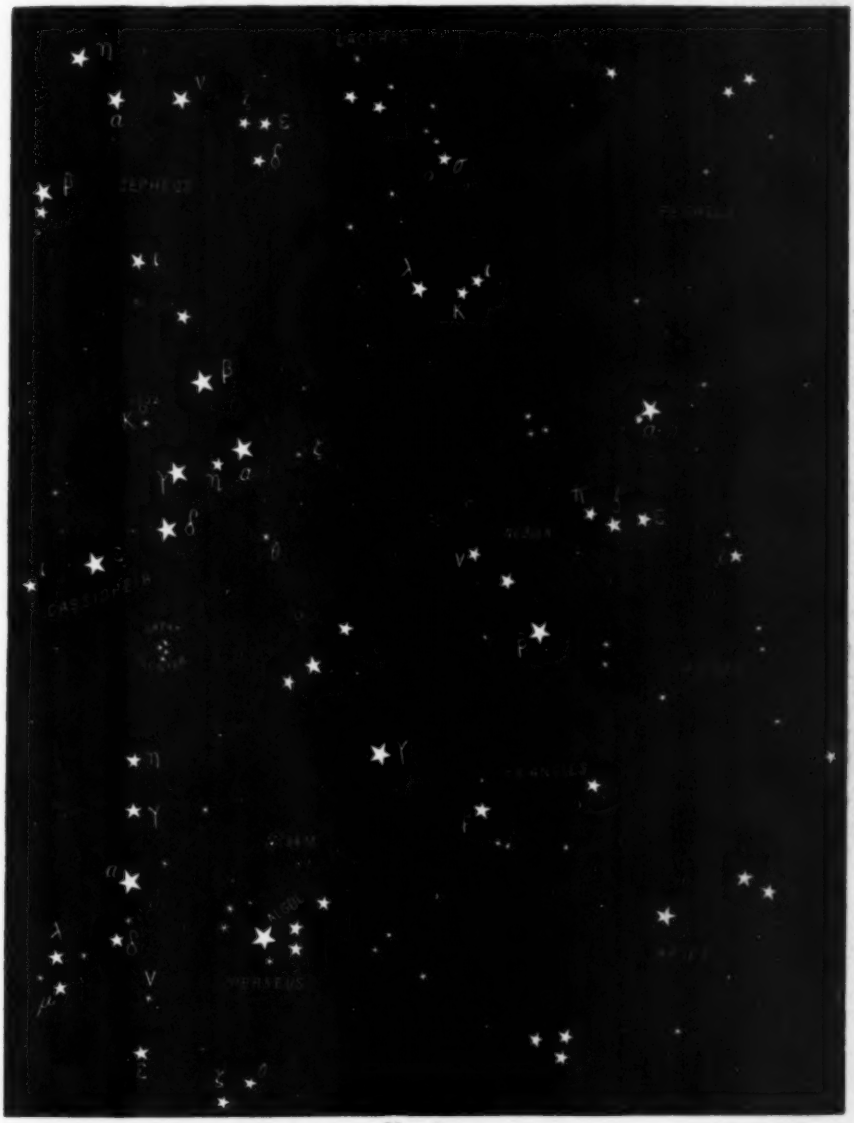
You will find it very interesting to take your glass and, beginning with the attractive little group in the Northern Fish, follow the windings of the ribbon, with its wealth of little stars, to the Western Fish. When you have arrived at that point, sweep well over the sky in that neighborhood, and particularly around and under the stars Iota (ι), Theta (θ), Lambda (λ) and Kappa (κ). If you are using a powerful glass, you will be surprised and delighted by what you see. Below the star Omega (ω), and to the left of Lambda, is the place which the sun occupies at the time of the spring equinox—in other words, one of the two crossing-places of the equinoctial or the equator of the heavens, and the ecliptic, or the sun's path. The prime meridian of the heavens passes through this point.

To the left of Pisces, and above the head of Cetus, is the constellation Aries, or the Ram. Two pretty bright stars, four degrees apart, one of which has a fainter star near it, mark it out plainly to the eye. These stars are in the head of the Ram. The brightest one, Alpha (α) is called Arietis ; Beta (β) is named Sheratan ; and its fainter neighbor is Mesarthim. According to fable, this constellation represents the ram that wore the golden fleece, which was the object of the celebrated expedition of the Argonauts. There is not much in the constellation to interest us, except its historical importance, as it was more than two thousand years ago the leading constellation of the zodiac, and still stands first in the list of the zodiacal signs. Owing to the precession of the equinoxes, however, the vernal equinoctial point, which was formerly in this constellation, has now advanced into the constellation Pisces, as we saw above.

The little constellation of the Triangles, just above Aries, is worth only a passing notice. Insignificant as it appears, this little group is a very ancient constellation.

And now we come to the so-called "Royal Family." Although

the story of Perseus and Andromeda is, of course, well known to nearly all readers, yet, on account of the great beauty and brilliancy of the group of constellations that perpetuate the memory of it among the stars, it is worth recalling here. It will be remembered that, as



MAP 4.

Perseus was returning through the air from his conquest of the Gorgon Medusa, he saw the beautiful Andromeda chained to a rock on the sea-coast, waiting to be devoured by a sea-monster. The poor girl's only offense was that her mother, Cassiopeia, had boasted for

her that she was fairer than the sea-beauty, Atergatis, and for this Neptune had decreed that all the land of the Ethiopians should be drowned and destroyed unless Andromeda was delivered up as a sacrifice to the dreadful sea-monster. When Perseus, dropping down to learn why this maiden was chained to the rocks, heard from Andromeda's lips the story of her woes, he laughed with joy. Here was an adventure just to his liking, and besides, unlike his previous adventures, it involved the fate of a beautiful woman with whom he was already in love. Could he save her? Well, wouldn't he! The sea-monster might frighten a kingdom full of Ethiops, but it could not shake the nerves of a hero from Greece. He whispered words of encouragement to Andromeda, who could scarce believe the good news that a champion had come to defend her after all her friends and royal relations had deserted her. Neither could she feel much confidence in her young champion's powers when suddenly her horrified gaze met the awful monster of the deep advancing to his feast! But Perseus, with a warning to Andromeda not to look at what he was about to do, sprang with his winged sandals up into the air. And then, as Charles Kingsley has so beautifully told the story—

"On came the great sea-monster, coasting along like a huge black galley, lazily breasting the ripple, and stopping at times by creek or headland to watch for the laughter of girls at their bleaching, or cattle pawing on the sand-hills, or boys bathing on the beach. His great sides were fringed with clustering shells and sea-weeds, and the water gurgled in and out of his wide jaws as he rolled along, dripping and glistening in the beams of the morning sun. At last he saw Andromeda, and shot forward to take his prey, while the waves foamed white behind him, and before him the fish fled leaping.

"Then down from the height of the air fell Perseus like a shooting-star—down to the crest of the waves, while Andromeda hid her face as he shouted. And then there was silence for a while.

"At last she looked up trembling, and saw Perseus springing toward her; and instead of the monster, a long, black rock, with the sea rippling quietly round it."

Perseus had turned the monster into stone by holding the awful head of Medusa before his eyes; and it was fear lest Andromeda herself might see the Gorgon's head, and suffer the fate of all who looked upon it, that had led him to forbid her watching him when he attacked her enemy. Of course he married her, and of course Cassiopeia, Andromeda's mother, and Cepheus, her father, gave their daughter's rescuer a royal welcome, and all the Ethiops rose up and blessed him for ridding the land of the monster. And now, if we choose, we can, any fair night, see the principal characters of this old romance shining in starry garb in the sky. Aratus saw them there in his day, more than two hundred years before Christ, and has left this description in his "Skies," as translated by Poste:

"Nor shall blank silence whelm the harassed house
Of Cepheus; the high heavens know their name,
For Zeus is in their line at few removes.
Cepheus himself by She-bear Cynosure,
Iasid king stands with uplifted arms.
From his belt thou castest not a glance
To see the first spire of the mighty Dragon.

"Eastward from him, heaven-troubled queen, with scanty stars
But lustrous in the full-mooned night, sits Cassiopeia.
Not numerous nor double-rowed
The gems that deck her form,
But like a key which through an inward-fastened
Folding-door men thrust to knock aside the bolts,
They shine in single, zigzag row.
She, too, o'er narrow shoulders stretching
Uplifted hands, seems wailing for her child.

"For there, a woful statue form, is seen
Andromeda, parted from her mother's side. Long I trow
Thou wilt not seek her in the nightly sky,
So bright her head, so bright
Her shoulders, feet, and girdle.
Yet even there she has her arms extended,
And shackled even in heaven; uplifted,
Outspread eternally are those fair hands.

"Her feet point to her bridegroom
Perseus, on whose shoulder they rest.
He in the north-wind stands gigantic,
His right hand stretched toward the throne
Where sits the mother of his bride. As one bent on some high deed,
Dust-stained he strides over the floor of heaven."

The makers of old star-maps seem to have vied in the effort to represent with effect the figures of Andromeda, Perseus, and Cassiopeia among the stars, and it must be admitted that some of them succeeded in giving no small degree of life and spirit to their sketches.

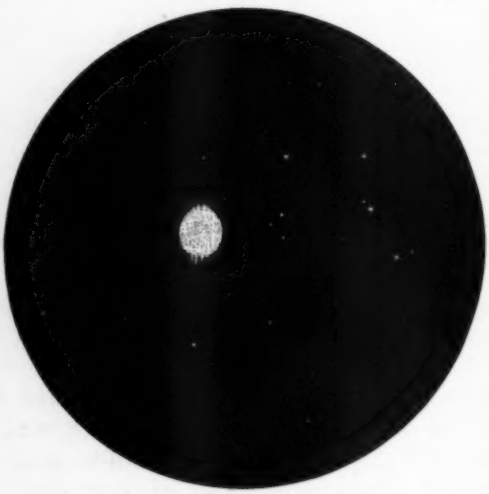
The starry riches of these constellations are well matched with their high mythological repute. Lying in and near the Milky-Way, they are particularly interesting to the observer with an opera-glass. Besides, they include several of the most celebrated wonders of the firmament.

In consulting our fourth map, the observer is supposed to face the east and northeast. We will begin our survey with Andromeda. The three chief stars of this constellation are of the second magnitude, and lie in a long, bending row, beginning with Alpha (α), or Alpheratz, in the head, which, as we have seen, marks one corner of the great Square of Pegasus. Beta (β), or Mirach, with the smaller stars Mu (μ) and Nu (ν), form the girdle. The third of the chief stars is Gamma (γ), or Almaach, situated in the left foot. The little group

of stars designated Lambda (λ), Kappa (κ), and Iota (ι), mark the extended right hand chained to the rock, and Zeta (ζ) and some smaller stars southwest of it show the left arm and hand, also stretched forth and shackled.

In searching for picturesque objects in Andromeda, begin with Alpheratz and the groups forming the hands. Below the girdle will be seen a rather remarkable arrangement of small stars in the mouth of the Northern Fish. Now follow up the line of the girdle to the star Nu (ν). If your glass has a pretty wide field, your eye will immediately catch the glimmer of the Great Nebula of Andromeda in the same field with the star. This is the oldest or earliest discovered of the nebulæ, and, with the exception of that in Orion, is the grandest visible in this hemisphere. Of course, not much can be expected of an opera-glass in viewing such an object; and yet a good glass, in clear weather and the absence of the moon, makes a very attractive spectacle of it.

By turning the eyes aside, the nebula can be seen, extended as a faint, wispy light, much elongated on either side of the brighter nucleus. The cut here given shows, approximately, the appearance of the nebula, together with some of the small stars in its neighborhood, as seen with a field-glass. With large telescopes it appears both larger and broader, expanding to a truly enormous extent, and in Bond's celebrated picture of it we behold gigantic rifts running through it, while the whole field of sky in which it is contained appears sprinkled over with minute stars apparently between us and the nebula. It was in, or probably more properly speaking, in line with, this nebula that a new star suddenly shone out in 1885, and, after flickering and fading for a few months, disappeared. That the outburst of light in this star had any real connection with the nebula is exceedingly improbable. Although it appeared to be close beside the bright nucleus of the nebula, it is likely that it was really hundreds or thousands of millions of miles either this side or the other side of it. Why it should suddenly have blazed into visibility, and then in so short a time have disappeared, is a question as difficult as it is interesting. The easiest way to account for it, if not the most satisfactory,



MAP 5.—THE GREAT ANDROMEDA NEBULA.

is to assume that it is a variable star of long period, and possessing a very wide range of variability. One significant fact that would seem to point to some connection between star and the nebula, after all, is that a similar occurrence was noticed in the constellation Scorpio in 1860, and to which I have previously referred (see "Popular Science Monthly" for June, 1887). In that case a faint star projected against the background of a nebula, suddenly flamed into comparatively great brilliancy, and then faded again. The chances against the accidental superposition of a variable star of such extreme variability upon a known nebula occurring twice are so great that for that reason alone we might be justified in thinking some mysterious causal relation must in each case exist between the nebula and the star. The temptation to indulge in speculation is very great here, but it is better to wait for more light, and confess that for the present these things are inexplicable.

It will be found very interesting to sweep with the glass slowly from side to side over Andromeda, gradually approaching toward Cassiopeia or Perseus. The increase in the richness of the stratum of faint stars that apparently forms the background of the sky will be clearly discernible as you approach the Milky-Way, which passes directly through Cassiopeia and Perseus. It may be remarked that the Milky-Way itself, in that splendidly rich region about Sagittarius (described in the "Stars of Summer"), is not nearly so effective an object with an opera-glass as it is above Cygnus and in the region with which we are now dealing. This seems to be owing to the smaller magnitude of its component stars in the southern part of the stream. There the background appears more truly "milky," while in the northern region the little stars appear distinct, like diamond-specks on a black background.

The star Nu, which serves as a pointer to the Great Nebula, is itself worth some attention with a pretty strong glass on account of a pair of small stars near it.

Next let us turn to Perseus. The bending row of stars marking the center of this constellation is very striking and brilliant. The brightest star in the constellation is Alpha, or Algenib, in the center of the row. The head of Perseus is toward Cassiopeia, and in his left hand he grasps the head of Medusa, which hangs down in such a way that its principal star Beta, or Algol, forms a right angle with Algenib and Almaach in Andromeda. This star Algol, or the Demon, as the Arabs call it, is in some respects the most wonderful and interesting in all the heavens. It is as famous for the variability of its light as Mira, but it differs widely from that star both in its period, which is very short, and in the extent of the changes it undergoes. During about two days and a half, Algol is equal in brilliancy to Algenib, which is a second-magnitude star; then it begins to fade, and in the course of about four and a half hours it sinks to the fourth magnitude,

being then about equal to the faint stars near it. It remains thus obscured for only a few minutes, and then begins to brighten again, and in about four and a half hours more resumes its former brilliancy. This phenomenon is very easily observed, for, as will be seen by consulting our little map, Algol can be readily found, and its changes are

MAP 6.—THE ATTENDANTS OF ALPHA PERSEI.

so rapid that under favorable circumstances it can be seen in the course of a single night to run through the whole gamut. Of course, no optical instrument whatever is needed to enable one to see these changes of Algol for it is plainly visible to the naked eye throughout, but it will be found interesting to watch the star with an opera-glass. Its periodic time from minimum to minimum is two days, twenty hours, and forty-nine minutes, lacking a few seconds. Any one can calculate future minima for himself by adding the periodic time above given to the time of any observed minimum. For instance, there will be a minimum on November 12th at about 11.15 P. M., then the next minimum will occur two days, twenty hours and forty-nine minutes later, or at 8.04 P. M., on November 15th.

While spots upon its surface may be the cause of the variations in

the light of Mira, it is believed that the more rapid changes of Algol may be due to another cause; namely, the existence of a huge, dark body revolving swiftly around it at close quarters in an orbit whose plane is directed edgewise toward the earth, so that at regular intervals this dark body causes a partial eclipse of Algol. Notwithstanding the attacks that have been made upon this theory, it seems to hold its ground, and it will probably continue to find favor as a working hypothesis until some fresh light is cast upon the problem. It hardly needs to be said that the dark body in question, if it exists, must be of enormous size, bearing no such insignificant proportion to the size of Algol as the earth does to the sun, but being rather the rival in bulk of its shining brother—a blind companion, an extinguished sun.

There was certainly great fitness in the selection of the little group of stars of which this mysterious Algol forms the most conspicuous member, to represent the awful head of the Gorgon carried by the victorious Perseus for the confusion of his enemies. In a darker age than ours the winking of this demon star must have seemed a prodigy of sinister import.

Turn now to the bright star Algenib, or Alpha Persei. You will find with the glass an exceedingly attractive spectacle there. In my note-book I find this entry, made while sweeping over Perseus for materials for this article: "The field about Alpha is one of the finest in the sky for an opera-glass. Stars conspicuously ranged in curving lines and streams. A host follows Alpha from the east and south." The picture above will give the reader some notion of the exceeding beauty of this field of stars, and of the singular manner in which they are grouped, as it were, behind their leader. A field-glass increases the beauty of the scene.

The reader will find a starry cluster marked on Map 4 as the "Great Cluster." This object can be easily detected by the naked eye, resembling a wisp of luminous cloud. It marks the hand in which Perseus clasps his diamond sword, and, with a telescope of medium power, it is one of the most marvelously beautiful objects in the sky —a double swarm of stars, bright enough to be clearly distinguished from one another, and yet so numerous as to dazzle the eye with their lively beams. An opera-glass does not possess sufficient power to "resolve" this cluster, but it gives a startling suggestion of its half-hidden magnificence, and the observer will be likely to turn to it again and again with increasing admiration. Sweep from this to Alpha Persei and beyond to get an idea of the procession of suns in the Milky-Way. The nebulous-looking cluster marked 34 M appears with an opera-glass like a faint comet.

Next look at Cassiopeia, which is distinctly marked out by the zigzag row of stars so well described by Aratus. Here the Milky-Way is so rich that the observer hardly needs any guidance; he is sure to stumble upon interesting sights for himself. The five brightest stars

are generally represented as indicating the outlines of the chair or throne in which the queen sits, the star Zeta (ζ) being in her head. Look at Zeta with a good field-glass, and you will see a singular and brilliant array of stars near it in a broken half-circle, which may suggest the notion of a crown. Near the little star Kappa (κ) in the map will be seen a small circle and the figures 1572. This shows the spot where the famous temporary star, which has of late been frequently referred to as the "Star of Bethlehem," appeared. It was seen in 1572, and carefully observed by the famous astronomer Tycho Brahe. It seems to have suddenly burst forth with a brilliancy that outshone every other star in the heavens, not excepting Sirius itself. But its supremacy was short-lived. In a few months it had sunk to the second magnitude. It continued to grow fainter, exhibiting some remarkable changes of color in the mean time, and in less than a year and a half it had disappeared. It has never been seen since. But in 1264, and again in 945, a star is said to have suddenly blazed out near that point in the heavens. There is no certainty about these earlier apparitions, but, assuming that they are not apocryphal, they might possibly indicate that the star seen by Tycho was a periodical one, its period considerably exceeding three hundred years. Carrying this supposed period back, it was found that an apparition of this star might have occurred about the time of the birth of Christ. It did not require a very prolific imagination to suggest its identity with the so-called star of the Magi, and hence the legend of the Star of Bethlehem and its impending reappearance of which we have heard so much of late. It will be observed, from the dates given above, that, even supposing them to be correct, no definite period is indicated for the reappearances of the star. In one case the interval is three hundred and eight years, and in the other three hundred and nineteen years. In short, there are too many suppositions and assumptions involved to allow of any credence being given to the theory of the periodicity of Tycho's wonderful star. At the same time, nobody can say it is impossible that the star should appear again, and so it may be interesting for the reader to know where to look for it.

Many of the most beautiful sights of this splendid constellation are beyond the reach of an opera-glass, and reserved for the grander powers of the telescope.

We will pause but a minute with Cepheus, for the old king's constellation is comparatively dim in the heavens, as his part in the dramatic story of Andromeda was contemptible, and he seems to have got among the stars only by virtue of his relationship to more interesting persons. He does possess one gem of singular beauty—the star Mu, which may be found about half-way from Alpha to the group of stars in the king's head, named Zeta (ζ), Epsilon (ε), and Delta (δ), and a little southwest of a line joining them. It is the so-called "Garnet Star," thus named by William Herschel, who advises the observer,

in order to appreciate its color, to glance from it to Alpha Cephei, which is a white star. Mu is variable, changing from the fourth to the sixth magnitude in a long period of five or six years. Its color is changeable, like its light. Sometimes it is of a deep garnet hue, and at other times it is orange-colored. Upon the whole, it appears of a deeper red than any other star visible to the naked eye.

If you have a good field-glass, try its powers upon the star Delta (δ) Cephei. This is a double star, the components being about forty-one seconds of arc apart, the larger of four and one half magnitude, and the smaller of the seventh magnitude. The latter is of a beautiful blue color, while the larger star is yellow or orange. With a good eye, a steady hand, and a clear glass, magnifying not less than six diameters, you can separate them, and catch the contrasted tints of their light. Besides being a double star, Delta is variable.

ABOUT THE WEDDING-RING.

By D. R. McANALLY.

OF all the ornaments with which vanity, superstition, and affection have decorated the human form, few have more curious bits of history than the finger-ring. From the earliest times the ring has been a favorite ornament, and the reasons for this general preference shown for it over other articles of jewelry are numerous and cogent. Ornaments whose place is on some portion of the apparel, or in the hair, must be laid aside with the clothing or head-dress; are thus easily lost and often not at once missed. Pins, brooches, buckles, clasps, buttons, all sooner or later become defective in some part, and are liable to escape from an owner unconscious of the defect in the mechanism. The links of a necklace in time become worn, and the article is taken off to be mended; the spring or other fastening of a bracelet is easily broken, and the bracelet vanishes. With regard to ornaments fastened to parts of the savage body, mutilation is necessary, the ear must be bored, the nose be pierced, the cheeks or lips be slit, and, even after these surgical operations are completed, the articles used for adornment are generally inconvenient, and sometimes, by their weight or construction, are extremely painful.

In striking contrast with decorations worn on the clothing, in the hair, round the neck and arms, or pendent from the ears, lips, and nose, is the finger-ring, the model of convenience. It is seldom lost, for it need not be taken off; requires no preparatory mutilation of the body, is not painful, is always in view, a perpetual reminder, either of the giver, or of the purpose for which it is worn.

The popularity of the ring must, therefore, be in large measure due to its convenience, and that this good quality was early learned may

be inferred from the Hebrew tradition, which attributes the invention of this ornament to Tubal-Cain, the "instructor of every artificer in brass and iron." The barbaric lover, in choosing a token for his mistress, was doubtless actuated, like the lover of to-day, by the wish to be kept in remembrance, and the proverbial saying, "Out of sight, out of mind," being as true in savage as in civilized times, he sought for a memento which should be always in view, never laid aside, not in danger of being lost—which, in short, should become a part of herself, mutely reminding her of him, and presenting a silent remonstrance when her affections went astray. For the purposes of a love-gift, he could find nothing more suitable than the ring. And when the agonies of courtship finally settled into the steady troubles of matrimony, it was not remarkable that this token of affection should remain on the finger of the bride, or be removed, to be succeeded by another of a similar kind.

The uses of the finger-ring have been many and diverse. Originally purely for ornament, it became a signet for kings and a warrant for their messengers; to civil officers it was once an emblem of office, and to ecclesiastics an indispensable portion of the episcopal costume. It was once worn by physicians to prevent contagion, and by patients to cure disease; the timorous wore it as a charm against evil spirits, and the ambitious clung to it as a talisman, giving the wearer success over his enemies. But as a love-token, and a symbol of marriage, the use of the ring is so general, and of so long standing, as to dwarf into insignificance its employment in all other directions.

At what period it came into play as a recognized factor in the marriage ceremony, it is impossible to say. The Hebrews used it in very early ages, and probably borrowed the custom from the Egyptians, among whom the wedding-ring was known—a circle, in the language of hieroglyphics, being the symbol of eternity, and the embodiment of the circle readily symbolizing the hypothetical duration of wedded love. The Greeks used wedding-rings, so did the Romans, both putting them on the forefinger—by-the-way, a practice followed by the mediæval painters, many of whom represent the Virgin's ring on her forefinger. In the East, where the popular estimate of woman is low, the use of the wedding-ring has not been common, though occasionally the favorite wife of an Oriental monarch would receive from her master a ring as a mark of his favor. The conclusion, therefore, is safe that, with increase of respect for the institution of marriage, come also increased respect for and use of the ring as a token of the alliance.

During a part of the middle ages, this respect showed itself in a peculiar way, custom demanding that the wedding-ring should cost as much as the bridegroom could afford to pay; and there are records in Germany and France, during the fourteenth and fifteenth centuries, of many large investments made in this direction by grooms eager to

conciliate their brides and be in the fashion. The revulsion made the ring what we now have, a plain gold circlet; though, by a compromise, the engagement-ring may be as costly as fancy dictates or means permit.

The materials of which wedding-rings have been composed are as diverse as the nations which have used the ring. The British Museum has rings of bone and of hard wood, found in the Swiss lakes; on one of the bone rings is traced a heart, giving antiquaries reason to believe that the ring was a pledge of affection, if not a wedding-ring. The same museum has rings from all parts of the earth—of bone, ivory, copper, brass, lead, tin, iron, silver, gold, and some of a composite of several of these metals. One ivory ring, from an Egyptian tomb, bears two clasped hands; an iron ring, having the design of a hand closing over a heart, once graced the hand of a Roman matron; while the inscriptions on many others make it certain that they were wedding-rings.

The use of many different materials in the construction of these wedding-rings does not indicate capricious changes of fashion, for it should be remembered that museums and collections of antiquities comprise specimens of many ages and of widely-separated lands, but there is no doubt that fashion has sometimes had an influence in determining the style and material of the ring. For instance: during the latter part of the sixteenth century a fashion for some time prevailed in France of making the wedding-ring consist of several links fastened together in such a way as to seem but one. Sometimes there were three, two links having graven hands and the third a heart, the union of the three in the proper position clasping the hands over the heart. During the palmy days of astrology, there was quite a fashion in Germany of wedding-rings engraved with astronomical and astrological characters, the horoscopes of both the contracting parties being sometimes indicated in the setting of the ring. That being also the golden age of the quack doctor, wedding-rings were often made with a cavity to contain medical preparations or charms to preserve or restore health or avert evil. After the Crusades had set Europe in a flame, a practice became common in France, Germany, and England, of wearing rings the setting of which was a tiny fragment of wood from the true cross, and many of these rings are still preserved in the cabinets and museums of Europe. Ass-hoof rings were, in the seventeenth century, very popular among the Spanish peasants as a cure for epilepsy; and such a ring, made, it was said, from the hoof of the ass which carried Christ into Jerusalem, was used in a wedding in a country church near Madrid in 1881!

But when the ring was not plain, precious stones of some kind constituted the settings; and when the selection of the stone was in question, the dominance of fashion was absolute. In the fourteenth century, a fanciful Italian writer on the mystic arts set forth the vir-

tues of the various gems, indicating also the month in which it was proper to wear particular stones in order to secure the best result. The idea took, and for some time it was the fashion in several Italian cities to have the precious stone of the ring determined by the month in which the bride was born. If in January, the stone was a garnet, believed to have the power of winning the wearer friends wherever she went. If in February, her ring was set with an amethyst, which not only promoted in her the quality of sincerity, but protected her from poison and from slanderous tongues. The blood-stone was for March, making her wise, and enabling her with patience to bear domestic cares; the diamond for April, keeping her heart innocent and pure so long as she wore the gem. An emerald for May made her a happy wife; while an agate, for June, gave her health and protection from fairies and ghosts. If born in July, the stone was a ruby, which tended to keep her free from jealousy of her husband; while in August, the sardonyx made her happy in the maternal relation. In September, a sapphire was the proper stone, it preventing quarrels between the wedded pair; in October, a carbuncle was chosen, to promote her love of home. The November-born bride wore a topaz, it having the gift of making her truthful and obedient to her husband; while in December the turquoise insured her faithfulness. Among the German country-folk, the last-named stone is to the present day used as a setting for the betrothal-ring, and, so long as it retains its color, is believed to indicate the constancy of the wearer.

From Italy this fanciful notion spread to France, and French bridegrooms would sometimes insure themselves against a bad matrimonial bargain, and, as far as they could, guarantee to their brides a variety of good qualities, by presenting twelve rings, one for each month, with occasionally one or two extra as special charms. However, this extravagance in the number of rings used at weddings is not a solitary instance, for the use of several rings at the marriage ceremony has often been known. Four rings placed on her hand at her marriage could not keep Mary Stuart faithful to Darnley; and the annals of European courts record many instances similar, both as to the rings and to the result. The Greek Church uses two rings, one of gold, the other of silver; while in some districts of Spain and Portugal, three rings are placed, one at a time, on the fingers of the bride, as the words, "In the name of the Father, and of the Son, and of the Holy Ghost," are pronounced.

Fashion has also determined, not only the style of the wedding-ring, but the finger on which it is to be worn; and so capriciously has custom varied, that the symbol of matrimony has traveled from the thumb to the fourth finger, where it now reposes. In the time of Elizabeth, it was customary, both in England and on the Continent, for ladies to wear rings on the thumb, and several of her rings now shown in the British Museum, from their size, must have been thumb-

rings. That the practice of wearing thumb-rings extended to the case of married ladies and their wedding-rings, is amply attested, not only by allusions in contemporary literature, but by the portraits of matrons of that age, a great many, where the hands are shown, displaying the wedding-ring on the left thumb. In the time of Charles II, the ring seems to have found lodgment on the forefinger, sometimes on the middle finger, occasionally on the third finger also, and, by the time George I came to the throne, the third finger was recognized as the proper place for it, not universally, however, for William Jones in his treatise on rings, declares that even then the thumb was the favorite place for the wedding-ring, and gives instances of the ring being made of large size, and, although placed on the third finger at the ceremony, immediately afterward removed to the thumb.

An English work on etiquette, published in 1732, says it is for the bride to choose on which finger the wedding-ring shall be placed. It further states that some prefer the thumb, since it is the strongest and most important member of the hand; others, the index-finger, because at its base lies the mount of Jupiter, indicating the noble aspirations; others, the middle finger, because it is the longest of the four; and others, again, the fourth finger, because a "vein proceeds from it to the heart."

The "British Apollo," however, decides the proper place of the ring to be the fourth finger, not because it is nearer the heat than the others, but because on it the ring is less liable to injury. The same authority prefers the left hand to the right. The right hand is the emblem of authority, the left of submission, and the position of the ring on the left hand of the bride indicates her subjection to her husband. A curious exception to the rule placing the ring on the left hand is, however, seen in the usage of the Greek Church, which puts the rings on the right hand.

As the symbol of matrimony, it is not strange that many of the superstitious fancies which have arisen in connection with the wedding should cluster about the ring. Dreaming on a bit of wedding-cake is common among American young ladies; but they should be informed that, for the dreaming to be properly done, the piece of cake thus brought into service should be passed through the wedding-ring, for so it is done in Yorkshire, Wales, and Brittany, in which localities the custom has been observed from time immemorial. The Russian peasantry not only invest the cake with wonderful qualities by touching it with the two rings used in the ceremony, but deem that water in which the rings have been dipped has certain curious beneficial properties.

In many country districts of Great Britain it is believed that a marriage is not binding on either party unless a ring is used; hence, curtain-rings, the church-key, and other substitutes, including a ring cut from a finger of the bride's glove, have been mentioned as devices

to meet an emergency, when a ring of the proper kind could not be procured in time. In parts of Ireland, however, there is a current belief that a ring of gold must be used, and jewelers in the country towns not infrequently hire gold rings to peasants, to be returned after the ceremony.

Blessing the ring gives it no small share of sanctity, and old missals contain explicit directions as to the manner in which this ceremony must be carried out. In the church-service as performed in the villages of England, the ring is frequently placed in the missal, the practice being, no doubt, a relic of the blessing once thought indispensable. The German peasant-women continue to wear the wedding-ring of the first husband, even after a second marriage, and a recent book of German travels mentions a peasant wearing, at one time, the wedding-rings of four "late lamenteds." An instance is known of a woman of German birth, who, after the death of her husband in a Western State, had the misfortune to lose her ring. She at once bought another, had it blessed, and wore it instead of the former, deeming it unlucky to be without a wedding-ring. Among the same class of people, stealing a wedding-ring is thought to bring evil on the thief, while breaking the emblem of marriage is a sure sign of speedy death to one or both of the contracting parties.

THE CHEMISTRY OF "OYSTER-FATTENING."

By W. O. ATWATER,
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NOT every lover of the oyster knows that the size and plumpness which are so highly prized in the great American bivalve, and which are so attractive in specimens on the half-shell or in the stew as to lead the average man to pay a considerable extra price for extra size, are not entirely natural; and even those who do know that the majority of the oysters in the market are artificially swollen by introducing water into the tissues are not all aware that the process by which this is done is closely analogous to that by which the food in our own bodies is conveyed through the walls of the stomach and other parts of the digestive apparatus and poured into the blood and lymph to do its work of nourishment.

Physiologists are, I believe, agreed that the passage of the digested food through the walls of the alimentary canal in man and other animals is, in large part, due to osmose or dialysis, and that the operation of this physical law is a very common one in the animal body. But the quantitative study of the chemical changes involved is generally rendered difficult or impossible by the very fact of their taking place in living animals where the application of chemical analysis is impossible. An opportunity is, however, offered by the oyster, which, since

it lives in water and has a body so constituted as to readily permit the inflow and outflow of water and solutions of salts, may be easily used for experiments. The results of the experiments have a practical as well as scientific interest, since they confirm the common explanation of the increase in bulk of oysters by "floating," and show that it is essentially a process of watering in which the bulk is increased without any corresponding increase, but rather, if anything, a loss of nutritive material.*

It is a common practice of oyster-dealers, instead of selling the oysters in the condition in which they are taken from the beds in salt water, to first place them for a time—forty-eight hours, more or less—in fresh or brackish water, in order, as the oyster-men say, to "fatten" them, the operation being called "floating" or "laying out." By this process the body of the oyster acquires such a plumpness and rotundity, and its bulk and weight are so increased, as to materially increase its selling value.

The belief is common among oyster-men that this "fattening" is due to an actual gain of flesh and fat, and that the nutritive value of the oyster is increased by the process. A moment's consideration of the chemistry and physiology of the subject will make it clear, not only that such an increase of tissue-substance in so short a time and with such scanty food-supply is out of the question, but that the increase of volume and weight of the bodies of the oysters is just what would be expected from the osmose which would naturally take place between the contents of the bodies of the oysters as taken from salt water and the fresh or brackish water in which they are floated.

If we fill a bladder with salt water, and then put it into fresh water, the salt water will gradually work its way out through the pores of the bladder, and, at the same time, the fresher water will enter the bladder; and, further, the fresh water will go in much more rapidly than the salt water goes out. The result will be that the amount of water in the bladder will be increased. The bladder will swell by taking up more water than it loses, while at the same time it loses a portion of the salt.

It does this in obedience to a physical law, to which the terms osmose and dialysis are applied. In accordance with this law, if a membranous sac holding salts in solution is immersed in a more dilute solution, or in pure water, the more concentrated solution will pass out, and at the same time the water, or more dilute solution, will pass in, and more rapidly. The escape of the concentrated and entrance of the dilute solution will be, in general, the more rapid the greater the difference in concentration and the higher the temperature of the two solutions. After the osmose has proceeded for a time, the two solutions will become equally diluted. When this equilibrium between

* The following statements are adapted from a paper presented to the last meeting of the American Fisheries Association.

the two is reached, the osmose will stop. If the sac which has become distended is elastic, it will, after osmose has ceased, tend to come back to its normal size, the extra quantity of solution which it has received being driven out again.

We should expect these principles to apply to the oyster. Roughly speaking, the body of the animal may be regarded as a collection of membranous sacs. It seems entirely reasonable to suppose that the intercellular spaces, and probably the cells of the body, would be impregnated with the salts of the sea-water in which the animal lives; and this supposition is confirmed by the large quantity of mineral salts which the body is found by analysis to contain, and which amount, in some cases, to over fourteen per cent of the water-free substance of the body.

It seems equally reasonable to believe that osmose would take place through both the outer coating of the body and the cell-walls of the animal's body. As long as the oyster stays in the salt water, the solution of salts within its body would naturally be in equilibrium with the water outside. When the animal is brought into fresh or brackish water, i. e., into a more dilute solution, we should expect the salts in the more concentrated solution within its body to pass out, and a larger amount of fresh water to enter, and produce just such a distention as actually takes place in the floating. If this assumption is correct, we should expect that the osmose would be the more rapid the less the amount of salts in the surrounding water, that it would proceed more rapidly in warm and more slowly in cold water; that it would take place whether the body of the animal is left in the shell or is previously removed from it; that the quantity of salts would be greatly reduced in floating; and that, if it were left in the water after the maximum distention had been reached, the imbibed water would pass out again, and the oyster would be reduced to its original size. Just such is actually the case. Oyster-men find that the oysters "fatten" much more quickly in fresh than in brackish water; warmth is so favorable to the process that it is said to be sometimes found profitable to warm artificially the water in which the oysters are floated. Although oysters are generally floated in the shell, the same effect is very commonly obtained by adding fresh water to the oysters after they have been taken out of the shell; indeed, I am told that this is a by no means unusual practice of retail dealers. Oysters lose much of their salty flavor in floating, and it is a common experience of oyster-men that, if the "fattened" oysters are left too long on the floats, they become "lean" again.

This exact agreement of theory and fact might seem to warrant the conclusion that the actual changes in the so-called fattening of oysters in floating are essentially gain of water and loss of salts. The absolute proof, however, is to be sought in chemical analysis. In the course of an investigation conducted under the auspices of the United

States Fish Commission, and which included examinations of a number of specimens of oysters and other shell-fish, I have improved the opportunity to test this matter by some analyses of oysters before and after floating. The results of the investigation are to be given in detail in one of the publications of the Commission,* in which the principles involved and some side-issues of the experiments will be discussed. I give here the main results, prefacing by brief accounts of the process of "floating" oysters as actually practiced by oyster-men.

The following very apposite statements † are by Professor Persifor Frazer, Jr., who attributes the changes mentioned to dialytic action:

> The oysters brought to our large markets on the Atlantic seaboard are generally first subjected to a process of "laying out," which consists in placing them for a short time in fresher water than that from which they have been taken.
>
> Persons who are fond of this animal as an article of food, know how much the "fresh" exceed the "salts" in size and consistency. The "Morris Coves" of this city [Philadelphia], while very insipid, are the plumpest bivalves brought to market. On the other hand, the "Absecoms" and "Brigantines," while of a better flavor (to those who prefer salt oysters), are invariably lean compared to their transplanted rivals, as also are the "Cape Mays," though, for some reason, not to the same extent.
>
> The most experienced oyster-dealers inform me that the time for allowing the salt oysters taken from the sea-coast to lie out varies, but is seldom over two or three days. At the end of this time the maximum plumpness is attained, and beyond this the oyster becomes lean again, besides having lost in flavor.

The subjoined statements by Lieutenant J. A. Ryder are interesting in this connection. They are taken from a letter to Professor Baird, United States Commissioner of Fish and Fisheries, on "Floats for the So-called Fattening of Oysters": ‡

> The simplest and most practical structures of the kind which I have seen are the storage and fattening floats used by Mr. Conger, of Franklin City, Maryland, and now in use by all the shippers and planters in the vicinity of Chincoteague Bay. I have been informed that similar structures, or rather structures serving similar purposes, are in use on the oyster-beds along the shore of Staten Island, New York.
>
> It is probably a fact that in all these contrivances they take advantage of the effect produced by fresher water upon oysters which have been taken from slightly salter water. The planters of Chincoteague call this "plumping the oysters for market." It does not mean that the oysters are augmented in volume by the addition of substantial matter, such as occurs during the actual appropriation of food, but only that the vascular spaces and vessels in the animals are filled with a larger relative amount of water due to endosmose. It is a dealer's trick to give his produce a better appearance in the market, and as such I do not think deserves encouragement, but rather exposure.

* A detailed account is also to appear soon in the "Zeitschrift für Biologie."

† "Note on Dialysis in Oyster-Culture," in "Proceedings of Philadelphia Academy of Sciences," 1875, p. 472.

‡ "Bulletin of the United States Fish Commission," 1884, p. 302.

Mr. Conger has actually resorted to warming fresh water to 60° Fahr. in winter, by steam-pipes running underneath the wooden inclosure surrounding the "fattening" or "plumping" float. One good "drink," as he expressed himself to me, renders the animals fit for sale and of better appearance.

Conger's floats are simply a pair of windlasses supported by two pairs of piles driven into the bottom. Chains or ropes which wind upon the windlasses pass down to a pair of cross-pieces, upon which the float rests, which has a perforated or strong slat bottom, and a rim eighteen inches to two feet high. These floats I should think are about eight feet wide and sixteen feet long, perhaps twenty. These structures are usually built alongside the wharves of the packing and shipping houses, and are really a great convenience in conducting the work.

Elsewhere Lieutenant Ryder speaks of the floats thus:

The diaphragm itself was constructed of boards perforated with auger-holes, and lined on the inside with gunny-cloth or sacking; and the space between the perforated boards was filled with sharp, clean sand. The space between the boards was about two inches; through this the tide ebbed and flowed, giving a rise and fall of from four to six inches during the interval between successive tides.

Mr. F. T. Lane, of New Haven, Connecticut, writes as follows about the method of floating practiced by himself, and, as I understand, by other New Haven oyster-growers:

We do not always leave them two days in the floats—as a rule, only one day. We put them into brackish water and take them out at low water or in the last of the falling tide, as then the water is the freshest and the oysters are at their best. As it is not convenient for us to put them into the floats and take them out the same day, we do not want the water too fresh. On one occasion, wishing to know what the result would be of putting the oysters into water that was quite fresh, I had one of my floats taken up the river, half a mile farther than where we commonly use them, and one hundred bushels of oysters put into it at high water and taken out at low water. They were in the water from six to seven hours and came out very nice, fully as good as those floated twenty-four hours in the brackish water. It was a warm day, and the water was warm. Under these conditions they will drink very quickly. I have seen them open their shells in ten minutes after they were put into the water.

For the following valuable information I am indebted to Mr. R. G. Pike, chairman of the Board of Shell-fish Commissioners of Connecticut:

Connecticut oysters, when brought from their beds in the salt waters of Long Island Sound, are seldom sent to market before they have been subjected to more or less manipulation. As soon as possible after being gathered, they are deposited in shallow-tide rivers where the water is more or less brackish, and are left there from one to four days; the time varying according to the temperature of the season, the saltness of the oysters, and the freshening quality of the water. Generally two tides are sufficient for the two "good drinks" which the oyster-men say they should always have.

This "floating," as it is called, results in cleaning out and freshening the oysters, and increasing their bulk; or, as many oyster-men confidently assert,

"fattening" them. If the weather is warm, they will take a "drink" immediately, if not disturbed; but if the weather is cold, they will wait sometimes ten or twelve hours before opening their valves. Good fat oysters generally yield five quarts of solid meat to the bushel; but, after floating two tides or more, they will measure six quarts to the bushel. After they have been properly floated they are taken from the shell—and as soon as the liquor is all strained off, they are washed in cold fresh water—and are then packed for market. In warm weather they are put into the water with ice, and are also packed with ice for shipping. Water increases their bulk by absorption and by mixing with the liquor on the surface of the oysters. The salter the oyster the more water it absorbs. In twelve hours one gallon of oysters, with their juices strained out, will take in a pint of water; but when very salt and dry, they have been known to absorb a pint in three hours.

Water always thickens the natural juices that adhere to the surface of the oyster, and makes them slimy. If too much water is added, the oyster loses its plumpness and firmness and becomes watery and flabby.

Oysters that have been floated bear transportation in the shell much better than when shipped directly from their beds. Oysters, too, that are taken from their shells and packed in all their native juices spoil much sooner than when their juices are strained out and the meats are washed in fresh cold water.

Long clams are not floated, but round clams are. But both, when shucked, are washed in fresh water. This cleanses them of mud, sand, and excess of salt, increases their bulk, and improves their flavor. After washing they will keep much longer without risk of spoiling. If the salt is left in them, as they come from their native beds, their liquor will ferment, and they will quickly spoil.

The above facts are gathered from the most intelligent men in the shell-fish business in Connecticut—men who have had many years' experience in gathering oysters and clams, and preparing them for home and foreign consumption. They are all agreed that by judicious floating in the shell, and by washing and soaking when out of the shell, the oyster and the clam increase in bulk and improve in quality and flavor. We will not presume to say that this increased bulk is anything more than a mechanical distention of the organs and the cellular tissues of the oyster by water; or that its improved flavor is not due simply to a loss of bitter sea-salt dissolved out by the water. Many intelligent cultivators are confident that the increase in bulk is a growth of fat; while just as many, of equal intelligence, declare that it is mere "bloat" or distention, akin to that of a dry sponge when plunged into the water. The exact nature of the change the chemist alone can determine.

The following experiments were made with oysters courteously supplied by Mr. Lane, a communication from whom was just quoted. The oysters had been brought from the James and Potomac Rivers, and "planted" in the beds in New Haven Harbor (Long Island Sound) in April, and were taken for analysis in the following November.

Two experiments were made. The plan of each experiment consisted in analyzing two lots of oysters, of which both had been taken from the same bed at the same time, but one had been "floated" while the other had not. For each of the two experiments, Mr. Lane selected, from a boat-load of oysters as they were taken from the salt water, a number, about three dozen, which fairly represented the

whole boat-load. The remainder were taken to the brackish water of a stream emptying into the bay and kept upon the floats for forty-eight hours, this being the usual practice in the floating of oysters in this region. At the end of that time, the oysters were taken from the floats, and a number fairly representing the whole were selected as before. Two lots, one floated and the other not floated, were thus taken from each of two different beds. The four lots were brought to our laboratory for analysis.

The specimens as received at the laboratory were weighed. Thereupon, the shell-contents were taken out, and the shells and shell-contents both weighed. The solid and liquid portions of the shell-contents —i. e., the flesh or "solids" and liquor or "liquids"—were weighed separately, and then analyzed. We thus had, for each lot, the weights of flesh and liquids which, together made the weight of the total shell-contents, and the weight of the shells, which with that of the shell-contents made the weight of the whole specimens. We also had, from the analyses, the percentages of water, nutritive ingredients, salts, etc., in the flesh and in the liquids. From these data the calculations were made of the changes which took place in floating. For the details, which are somewhat extended, I may refer to the publication mentioned above. It will suffice here to give only the main results. It is assumed that the changes in the composition of the body of the animal, due to respiration, nutrition, excretion, etc., during the floating would be too small to be taken into account.

The body of the animal may be regarded as made up of water and so-called water-free substance. The water-free substance contains the nutritive ingredients or "nutrients." These may be divided into four classes: 1. Protein compounds, the so-called "flesh-formers," which contain nitrogen*; 2. Fatty substances, classed as fats; 3. Carbohydrates; 4. Mineral salts. These constituents of the flesh of oysters have been but little studied. It is customary to assume them to be similar to the corresponding compounds of other food-materials, but very probably the difference, if known, might prove to be important. The mineral matters especially, which are very large in amount, appear to include considerable of the salts of sea-water. Of the nature of the ingredients of the liquids but little is known. They consist mainly of water and salts and the amounts of their ingredients which are commonly reckoned as protein, fats, and carbohydrates, are very small, so that whatever error there may be in classing them with the ordinary nutrients of food, it will not very seriously affect the estimates of nutritive values.

During the sojourn in brackish water, both the flesh (body) and the liquid portion of the shell-contents of the oysters suffered more or less alterations in composition. In order to show clearly what the principal changes, as shown by the chemical analyses, were, it may per-

* The protein is estimated in the usual way by multiplying the nitrogen by 6·25.

haps be permissible to cite a few of the statistics. I give more details than would perhaps be appropriate in these pages, were it not for the novelty of the results, and the importance of their bearing upon the physiology of absorption of nutritive material in our bodies as well as upon the nutritive value of the oysters.

The changes in the constituents of the body ("flesh") were mainly such as would be caused by osmose, though there were indications of secretion of nitrogenous matters and, especially, of fats, which are not so easily explained by osmose. This I will speak of later.

The amounts of gain and loss of constituents which the bodies of the oysters experienced may be estimated either by comparing the percentages found by analysis before and after dialysis, or by comparing the absolute weight of a given quantity of flesh and the weights of each of its ingredients before, with the weights of the same flesh and of its ingredients after, dialysis. For the estimate by the first method we have simply to compare the results of the analyses of the floated and the not-floated specimens. Taking the averages of the two experiments, it appears that—

The percentages of—	Before dialysis.		After dialysis
Water rose from	77·9	to	82·4
Water-free substance fell from	22·1	"	17·6
Total flesh	100·0		100·0
Protein fell from	10·5	to	8·9
Fat fell from	2·5	"	1·9
Carbohydrates, etc., fell from	6·9	"	5·2
Mineral salts fell from	2·2	"	1·6
Total water-free substance in flesh	22·1		17·6

There was, accordingly, a gain in the percentage of water and a loss in that of each of the ingredients of the water-free substance. This accords exactly with the supposition that during the floating the flesh gained water and lost salts and other ingredients.

It will be more to the point to note the absolute increase and decrease in amounts of flesh and its constituents—in other words, the absolute gain or loss of each in the floating. Estimates by this method have been made and explained in the detailed accounts referred to. They make it appear that 100 grammes of the flesh as it came from the salt water was increased by floating, in one specimen, to 120·9, and in the other to 113·4 grammes. This is equivalent to saying that the two specimens of flesh gained in the floating, respectively, 20·9 and 13·4 per cent, or, on the average, 17·3 per cent of their original weight. By the same estimates the water-free substance in the 100 grammes of flesh before the floating weighed, on the average, 22·1 grammes, while that of the same flesh after floating weighed only 20·6 grammes, making a loss of 1·5 gramme or 6·6 per cent of the 22·1 grammes which the water-free substance weighed before dialysis. The main

results of the two experiments thus computed, may be stated as follows:

In the "floating" of 100 grammes of flesh (body) of the oysters—

The weight of—	Before dialysis.			After dialysis.	
Water rose from	77·9	grammes	to	96·6	grammes.
Water-free substance fell from	22·1	"	"	20·6	"
Whole flesh rose from	100·0	"	"	117·2	"
Protein was assumed to remain the same.	10·5	"	"	10·5	"
Fats fell from	2·5	"	"	2·3	"
Carbohydrates, etc., fell from	6·9	"	"	6·0	"
Mineral salts fell from	2·2	"	"	1·8	"
Total	22·1	"		20·6	"

In brief, according to these computations, the flesh lost between one sixth and one seventh of its mineral salts, one eighth of its carbohydrates, and one twelfth of its fats, but gained enough water to make up this loss and to increase its whole weight by an amount equal to from one seventh to one fifth of the original weight. Assuming the loss of nutritive value to be measured by the carbohydrates and fats which escaped, it would amount to about one tenth of the whole. That is to say, the total nutritive materials were one tenth less after floating than before.

In the liquid portion of the shell-contents, the percentage of water rose and that of the water-free substance fell in a very marked degree. But while the whole percentage of water-free substance was diminished, that of both protein and of carbohydrates rose slightly (the amount of fats was too small to be taken into account), so that the falling off was all in the mineral salts. The experiments do not show the exact increase or decrease in the total amounts of the liquids and their constituents, so that it is impossible to say with entire certainty whether there was or was not an actual gain of protein or fats or carbohydrates. It would seem extremely probable, however, that the liquids received and retained small quantities of these materials from the flesh (bodies) of the animals.

The apparent increase of protein and other materials belonging to the body in the liquids, though slight, is very interesting. I must refer to the detailed account of the experiments for the discussion of it and of the changes in composition of the liquids. The point is that if the changes in composition of the oysters in floating were due to osmose or dialysis alone, we should expect simply a gain of water and loss of salts (and perhaps of soluble carbohydrates). But the flesh seems to have lost a little carbohydrates and fats, and probably protein also, along with the salts, while it was absorbing water, the liquids at the same time gaining more or less of protein and carbohydrates. A way in which this may have come about is suggested by my colleague, Professor Conn, who calls attention to the fact that some mol-

lusks, when irritated, produce an extremely abundant secretion of mucus or "slime"—so much, indeed, as to sometimes render a small quantity of water in which the animals may be confined, quite sensibly gelatinous. He suggests that the change to fresh water may induce such a secretion of mucus, and perhaps of carbohydrates and fats as well, as would account for the increase of these substances in the liquids. The observation of oyster-dealers that "water always thickens the natural juices that adhere to the surface of the oyster and makes it slimy," accords with Professor Conn's statement.

If such secretion did take place, the flesh must probably have lost a little protein during the floating. The estimates of absolute gain and loss of weight of flesh and ingredients are based upon the assumption that the quantity of protein was unaltered in floating. If protein was given off, therefore, the estimates are wrong. But the quantity of protein secreted and the consequent error must be, at most, very slight. If there is an error, its effect would be to make the quantities of nutrients after floating appear larger than they really were. In other words, if the error were corrected, it would make the loss of nutritive material in floating greater than it appears to be in the figures above given.

The experiments might have been so conducted as to decide this question of the exact gain and loss of weight of each material in the oysters. It would have been necessary to simply take a larger number in each lot before and after floating, and be certain that the number, weight, and bulk were the same in the floated and not-floated lots of each experiment. For instance, we might, in each experiment, carefully select two lots of, say, a bushel each, as taken from the beds; have the number of oysters the same in each bushel, as an additional assurance that the two lots were alike; float one bushel, and weigh and analyze both. A few experiments of this sort made under different conditions of time, temperature, kind, and age of oysters, etc., would give very reliable and valuable data. Unfortunately, the means at my disposal did not permit so thorough experiments. I am persuaded, however, that the results of such series of trials, if they could be made—and I wish they might be—would be very similar to those of the trials here reported.

It is very interesting to note that these processes of both osmose and secretion which we have been considering in the body of the oyster are apparently very similar to processes which go on in our own bodies—namely, those by which our food, after it is digested, finds its way through the walls of the stomach and other parts of the alimentary canal into the blood, to be used for nourishment. Physiologists tell us that the passage of the digested materials through the walls of the canal is in part merely a physical action, due to osmose, but that it is in part dependent upon a special activity of the cells of the villi. In like manner, the changes in the composition of the oys-

ter, if the above explanation is correct, are caused partly by osmose, and partly by special secretive action, the cell-walls and outer coat of the body of the oyster corresponding to the walls of the alimentary canal in the human body. The forms of vital activity in the two cases are different, but osmose is concerned in both.

The main points here urged may be very briefly summarized:

1. In the floating of oysters for the market, a practice which is very general, and is also used for other shell-fish, the animals are either taken direct from the beds in salt water, and kept for a time in fresher (brackish) water before they are opened, or water is added to the shell-contents after they are taken out of the shell. When thus treated, the body of the animal takes up water and at the same time parts with some of its salts, while small quantities of the nutritive ingredients also escape. The oysters thus become more plump, and increase considerably in bulk and weight, but the quantity of nutritive material, so far from increasing, suffers a slight loss.

2. In the experiments here reported, the increase in bulk and weight was from one eighth to one fifth of the original amounts. This is about the same as is said to occur in the ordinary practice of floating or "fattening" for the market. According to this, five quarts of oysters in their natural condition would take up water enough in "floating" to increase their bulk to nearly or quite six quarts, but the six quarts of floated oysters would contain about one tenth less of actual nutrients than the five quarts not floated.

3. The gain of water and loss of salts are evidently due to osmose. The more concentrated solution of salts in the body of the animal, as taken from salt water, passes into the more dilute solution (fresher water) in which it is immersed, while a larger amount of the fresher water at the same time enters the body. But part of the exchange, and especially that by which other materials, carbohydrates, protein, etc., are given off in small quantities, is more probably due to a special secretory action.

4. The flavor of oysters is often much improved by the removal of the salts in floating, and they are said to bear transporting and to keep better. When, therefore, the oyster-man takes "good fat oysters" which "yield five quarts of solid meat to the bushel" and floats them so that "they will yield six quarts to the bushel," and thus has an extra quart, and that a quart of the largest and highest-priced oysters, to sell, he offers his customers no more nutritive material—indeed, a trifle less—in the six quarts than he would have done in the five quarts if he had not floated them. But many people prefer the taste of the floated oysters, and since they buy them more for the flavor than for the nutriment (at ordinary prices, the nutrients in oysters cost the buyer from three to five times as much as similar nutrients in the better kinds of meat), doubtless very few customers would complain if they understood all the facts. And considering that the practice is

very general and the prices are regulated by free competition, the watering of oysters by floating in the shell is, perhaps, less reprehensible than at first thought it might seem. This phase of the question, however, it is not the purpose of this article to discuss.

5. From the standpoint of chemical physiology the most interesting outcome of the experiments is the very interesting parallelism they show between the processes by which the salts and other materials pass from within the body to the surrounding medium and those by which the digested materials of the food in man and other animals are conveyed through the walls of the alimentary canal into the blood and lymph to serve their purposes in nutrition. In each case the process seems to be due in part to osmose (dialysis) and in part to a special function of the organs.

To recapitulate still more briefly: The oysters in "floating" in fresher water, for some hours after they were taken from the beds in salt water, as is commonly done in preparing them for the market, gained from one eighth to one fifth in bulk and weight by taking up water, but at the same time lost about one tenth of their nutritive material. They did this by processes essentially similar to those which go on in our own bodies, and by which the digested food passes from the alimentary canal into the blood, to be used for nourishment.

GEIKIE ON THE TEACHING OF GEOGRAPHY.*

By FREDERIK A. FERNALD.

GEOGRAPHY has been the last of the sciences which are studied in school to be affected by the modern demand that science shall be taught according to the scientific method. It is extremely important that this method of teaching the description of the earth should speedily become general, for most pupils study geography, and those who leave school at an early age may not otherwise obtain that quickening of the powers of observation and inference which the study of science gives.

Furthermore, to quote Professor Geikie, "Geography, in the wide and true sense of the word, offers admirable scope for this kind of training. It may be begun on the very threshold of school-life, and may be pursued in ever-increasing fullness of detail and breadth of view up to the end of that time. No other subject can for a moment be compared with it in this respect. It serves as common ground on which the claims of literature, history, and science may be reconciled." In order to aid teachers in leading their pupils into the study of

* "The Teaching of Geography. Suggestions regarding Principles and Methods for the Use of Teachers." By Archibald Geikie, LL. D., F. R. S. London and New York: Macmillan & Co. Pp. 202. Price, 60 cents.

geography by the natural method, Professor Geikie has written a little manual, which broadly sketches the plan to be adopted. The following paragraphs embody the principal features of this plan :

To begin the teaching of geography with formal lessons on the shape of the earth, parallels, meridians, equator, poles, and the rest, is to start at the wrong end. To the average boy or girl of six or seven years these details have no meaning and no interest. Their introduction on the very threshold of geographical instruction is a characteristic feature of our system, or rather want of system, in this department of education. They are very generally placed at the beginning of our class-books, and being there, they form, as a matter of course, the subjects of the first lessons usually given in geography. An altogether inordinate value is set by us upon class-books. Instead of serving, as they ought, merely to furnish the text for the fuller and more interesting exposition of the teacher, these books are for the most part slavishly followed.

The lesson of the day too often consists in the repetition by rote of so many sentences or paragraphs from the class-book, which are seldom expanded or made more attractive and intelligible by elucidation on the part of the teacher. Such instruction, if it may be so called, is bad for the teacher and worse for the taught. It is especially pernicious to the children in the earlier stages of their geographical studies, for it tortures their memories and brings no compensating advantage. It fosters idleness and listlessness on the part of the teacher, who, instead of exerting his faculties to invest the subject with a living interest, becomes for the time a mere machine, mechanically acting within the limits prescribed in the class-book.

In dealing with the young we should try to feel ourselves young again, to see things as they are seen by young eyes, to realize the difficulties that lie in the way of children's appreciation of the world around them, to be filled with an abounding sympathy which subdues all impatience on our side, and calls out on the side of the children their confidence and affection. Mutual sympathy and esteem are a pledge of enduring success. To cement this bond of union between teacher and taught there should be no set tasks for some considerable time. The lessons ought rather to be pleasant conversations about familiar things. The pupils should be asked questions such as they can readily answer, and the answering of which causes them to reflect, and gives them confidence in themselves and freedom with the teacher. The objects in the school-room, in the play-ground, on the road to school, should be made use of as subjects for such questionings, with the aim of drawing out the knowledge acquired by the pupils from their own observation. Every question should be one which requires for its answer that the children have actually seen something with their own eyes and have taken mental note of it. The putting of such questions stimulates the observing faculty, and not unfrequently

gives a chance of distinction to boys and girls whose capabilities are not well tested by the ordinary lessons of school.

But, while laying his foundations broadly in this way and widening the knowledge of his pupils, the teacher will do well to keep clearly before him some definite goal toward which the discipline of the elementary stage is to lead up. Probably no object can be suggested more fitting for this purpose than the thorough comprehension of a map. The power of understanding a map, and getting from it all the information it can afford, is an acquisition which lies at the base of all sound geographical progress. Yet how large a proportion, even of the educated part of the community, have only a limited and imperfect conception of the full meaning and uses of a map!

There is happily now a growing recognition of the principle that adequate geographical conceptions are best gained by observations made at the home locality. The school and its surroundings form the natural basis from which all subsequent geographical acquirement proceeds. Upon a groundwork of actual observation and measurement the young mind is led forward in a firm and steady progress. The school-room and play-ground serve as units from which an estimate is gradually formed of the relative proportions of more distant objects and places.

During infancy we learn that things differ in size and in distance from us. How much they differ in these respects is found out more slowly, if indeed discovered at all. Among the peasantry many adults may be met with who have hardly advanced a step beyond the infantile stage of perception. And even among those who consider themselves educated, it is sometimes ludicrous to see how absolutely untrained they are to judge with even an approach to accuracy of the relative sizes and distances of things. One of the most useful lessons, therefore, in the elementary part of geographical instruction, is to accustom the pupils to appreciate differences of size and proportion by actual measurement. The most convenient unit of measure to start with is the length of a pace, while the school-room is the most convenient place to try the first experiments in mensuration. By multiplying the measurements they have taken at school, the pupils will appreciate how far it is from school to their homes, what distance separates their village or town from the next, what is the size of their parish or county, and so on to the country as a whole, and eventually to the dimensions of the earth itself, and of planetary space.

If want of accuracy in judging of the dimensions of things is a common failing, not less prevalent is want of accuracy in judging of their relative positions, or what is called orientation. We begin in infancy with the difference between our right and left hands, and recognize things and places as lying to the right or left of us. But many of us hardly get beyond this rudimentary stage. It is almost incredible how helpless even educated people often are if asked to tell

whether one place lies to the north or south of another. They know that in passing between them you go to the right or left, as the case may be, but there their power of localization ends. What is needed is greater quickness and precision in orientation, and this ought to be acquired from early training at school.

When some progress has been made in elementary geographical conceptions, the blackboard should be brought into increasing use. After the school-room, for example, has been paced, and its dimensions and proportions have been thus ascertained, its plan should be drawn on the board by the teacher, with the relative positions of door, windows, and fireplace. From this beginning, gradual steps may be taken until the pupils can themselves draw on the board and on their slates rough plans of the school and of the play-ground. At first it will be sufficient to aim only at a general resemblance of proportion. The great object is to teach the young minds to realize the relations between the actual boundaries and the artificial representations of them. To succeed in this is by no means so easy as might be thought; but success in it is absolutely necessary, and must be attained no matter at what expenditure of time and labor. When it has been achieved, efforts should next be made to depict the plan to scale, and with a nearer approach to correctness.

It is desirable to ascertain and arrange the conceptions that children already possess as to time. They know that day and night follow each other in unbroken succession. They further know that each day has a morning, a noon, and an evening. These and their other notions should be drawn from them by questioning, and the answers, corrected by the class (or by the master if no member of the class has the requisite information), should be methodically summarized and repeated in the simplest language, as the basis of actual experience from which the pupils are to advance to further acquisitions of knowledge.

In taking the school surroundings as the basis of instruction, the teacher will readily recognize that, while the principle of his method remains the same, its details must necessarily vary according to the circumstances of the locality. The two most obvious distinctions are those of town and country. In a town, illustrations of the political side of geography are most prominent; in the country, it is the physical side that especially invites attention. The teacher should from the first realize that some of the most valuable parts of the training his pupils can receive are not attainable within the walls of the class-room. Where practicable, he should himself take walks with his pupils, and direct their attention to the objects to be seen as they go. There are, no doubt, practical difficulties in the way of carrying out this method, but these are generally not insurmountable.

In all these lessons, the system of question and answer must be scrupulously followed. Anything approaching to a style of lecturing

should be carefully avoided. Instead of appearing to discourse himself, the teacher should aim at obtaining clear, articulate expression of the knowledge and experience of the children. He may then judiciously sum up what has been gained during the lesson from the united experience of the whole class, and supplement it by filling in some of the more notable gaps. But the additions thus made by him to the common stock of acquirement should never be too preponderating a feature in the earlier lessons, and should come as naturally suggested by what has been obtained from the class.

It is often of advantage to let the lesson be suggested by some incident of the day, or something that has arrested notice since the previous lesson. The attention of the children is thereby riveted to the subject. They are ready to say all that they know about it, and eager to hear anything more which the teacher may tell them. A wet morning will profitably suggest a lesson on rain; the replenishing of the school-room fire with coal will furnish materials for another lesson, of a more advanced kind. The flitting of a butterfly through the open window of the school-room will suggest a lesson on insect-life, and give the teacher an opportunity of unfolding some of the wonders of the animal world and enforcing a reverence and sympathy for all living things. In short, his eye should be ever on the watch for materials on which he can train the observing and reflecting faculties of his scholars. If an incident likely to be of this useful kind should occur even in the midst of a lesson on another subject, he may profitably interrupt the work to direct attention to it that it may be distinctly seen, and he can afterward, at the proper time, return to the elucidation of it.

An observant teacher will not fail to notice that, long before children can understand or take any intelligent interest in the geography-lesson as ordinarily given in our schools, they are quite alive to the attractions of that large mass of phenomena embraced within the scope of what is called physical geography. They at first care little about the political boundaries or subdivisions of countries; but if you speak to them of the changes of the sky, the movements of the wind, the fall of rain, the nature of snow and frost, or of rivers, lakes, and glaciers, of waves and storms, of the soil and the plants that grow in it, of insects and birds and familiar quadrupeds, in short, of the outer world which they see around them from day to day, their attention is at once arrested. The subject is one that comes within the range of their own observation. And in education, the importance of connecting the subject of instruction with the personal experience of the pupils can hardly be overestimated. As the school district constitutes the basis from which, as far as possible, the pupils are to realize what the world is as a whole, early attention should be given to its natural features. Among these the configuration of the ground should claim special notice. In flat regions, it must obviously be less easy to find

practical exemplifications of this branch of the subject; though, even there, observation of the flow of water will reveal differences of level, and determine the highest and lowest ground.

A knowledge of the great movements of the air we breathe, and of the general laws that govern these movements, ought obviously to form an elementary part of any liberal education. The subject has attractions for old and young, since it includes a consideration of many of the most familiar occurrences of every-day life. Variations of weather, changes of temperature and moisture, the gathering of clouds, the rise of winds and storms—these and many other phenomena, which have fixed our attention from infancy, ought not to be the objects of mere gaping wonder. They should be intelligently appreciated, and the due comprehension of them should be begun during the early years of school-life.

From the rainfall, the transition is natural and easy to the flow of water over the land. The part of the rain that runs off in runnels and brooks can readily be followed. Where a stream exists in the school locality it should be made the text for the lessons on the flow of rivers, and the action of running water upon the surface of the land. The portion of the rain that sinks underneath the surface is less easily followed. But if there are any springs in the neighborhood of the school, they may be made an effective means of explaining the underground circulation of water. They should be revisited at different seasons, more particularly after drought and after heavy rains, when any appreciable variation in the volume of water may be detected, and the relation of the outflow to the rainfall may be enforced. Should the school be situated near the sea, an inexhaustible field of illustrations may be found along the shore. The phenomenon of the tides, which elsewhere can only be more or less intelligently followed from diagram and description, can here be actually seen every day. Besides the tides, the formation of waves may be observed at the coast; also their action in wearing away the edge of the land in one part, and heaping up shingle and sand at another.

In our methods of geographical instruction it has been too much the practice to ignore the biological side of geography. Yet, if we think of it, the forms of the land, the nature and distribution of the soils, the variations of climate, the systems of drainage, and the other features of the surface of the earth, derive, after all, their chief interest for us from the way in which they determine the conditions under which the living plants and animals of a country exist and flourish. The flora and fauna include so much of what makes the earth habitable and pleasant to man, that the description of them may be regarded as the highest subdivision of geographical narrative which finds its goal or crown in the characteristics and operations of man himself. No description of a region, therefore, and no mode of geographical instruction can be looked upon as complete, which do not

bring before us at least the more striking features in the general assemblage of plants and animals.

For the effective instruction of the young in that wide and important department of knowledge commonly but not very happily called political geography, the school locality forms an admirable center and starting-point. Such matters as the partitioning of the earth's surface into countries and parts of countries, the local names assigned to these subdivisions and to the natural features that diversify them, the position and growth of cities, towns, and villages, the distribution of population, the opening of communications by roads, canals, and railways, the distribution and increase of trades, manufactures, and commerce—these and other topics embraced within the same extensive subject can obviously be made at once intelligible and interesting if they are first considered with reference to the illustrations of them which the surroundings of school may supply.

The subjects treated of continuously and in logical sequence in the foregoing chapters need not, of course, be presented in such formal and methodical order to the pupils. As I have already insisted, they should be taught in a natural and spontaneous way. It is not, in the first instance, of such moment that any definite order should be followed, as that the subjects should be made attractive, and the interest of the pupils in them should be awakened and sustained. Whether the instruction has been given in a methodical or more desultory fashion, much varied information about the home locality will have been brought together. Before proceeding further, and enlarging the circle of vision by entering upon a wider geographical area beyond the personal acquaintance of the pupils, it will be found of great advantage to arrange and summarize this information. By so doing the teacher connects the scattered data, and illustrates in a memorable way the value of a principle of classification in helping us to deal intelligently with a multiplicity of facts. He, as it were, takes stock of the progress of his scholars at the end of the first stage of their geographical education, and makes an important forward step in the direction of more advanced teaching.

If I have succeeded in making clear my conception of the plan of education, it will be seen that the same practical method of instruction, so advantageous with regard to the home environment, should be continued when the horizon of vision widens. Already, before the lessons are begun that deal with the geography of the fatherland, allusions and suggestions have been made that have prepared the way for the fuller treatment of that subject, which, therefore, when at last reached, is not by any means unfamiliar. Though actual journeys beyond the limits of the parish or immediately surrounding district may not be possible, much advantage will be found in making imaginary ones, the teacher acting as leader, and guiding the scholars in traverses across the map. In the course of a series of traverses in various di-

rections from the school as a center, a considerable stock of miscellaneous information regarding the surrounding region will eventually be acquired by the pupils. Before they are ready to pass outward to a yet more extensive geographical survey, it will be desirable for them to pursue a similar course to that which they followed before quitting the consideration of the parish. They will be asked to arrange in summary form the information they have gathered, so as to compile a geographical description of another definite area of ground. In the United Kingdom, and generally in English-speaking countries, the next area after the parish for purposes of this kind is the county. And what now remains to be accomplished is to do for the native county what has already been done for the native parish.

The teacher is now in a position to consider the most important step that his scholars have yet taken in their geographical training. They have now to realize the relation borne by their own surroundings to the whole country. As before, this step must be taken deliberately upon a map, which ought to be a large, clearly engraved wall-map of the country, not overloaded with details. The first use of such a general map of the country probably requires a greater mental effort on the part of young learners than we usually suspect. It affords, however, according to the method of instruction here advocated, another and excellent opportunity of training the sense of proportion in geography. The faculty of readily appreciating the relation between the map and the area it represents; of recognizing the actual value of the distances expressed upon the map; of realizing from the engraved lines of water-course what must be the general disposition of the ground, should be sedulously cultivated from the very commencement of the employment of general maps of countries.

When the broad features of the country and the meaning of the more frequent geographical terms have been mastered by an attentive examination of the wall-map, there remains only the final step in the elementary stage of tuition, which is to pass outward from the country and realize its position upon the surface of the earth. I have alluded to the way in which the idea of the shape of the earth is to be impressed upon the minds of the learners. It is at the present stage of their training that this can most conveniently be accomplished. They have gradually had their ideas of geographical space extended from their own immediate surroundings, and are now prepared to realize the conception of the size and form of the whole planet. The simpler kinds of proof of the globular shape of the earth will be given, and the lesson will be illustrated from the school globe, which must now be brought into constant use. Having grasped the notion that they are living on a huge ball, the scholars will next be asked to find out upon the globe the position of their own country. Some little time should be spent in comparing the representation of the country there with that shown on the large wall-map already used. The out-

lines will be found to be still more generalized, and a crowd of details and names that occupied a place on the wall-map can no longer find room on the much smaller delineation of the country upon the globe. The lesson that was enforced in passing from the large parish plan to the county map, and from the county map to the general wall-map of the country, may now again be dwelt upon in advancing from the wall-map to the globe. And thus, by a continuous chain of illustration, the minds of the learners are led upward and outward from their school surroundings to realize the shape and dimensions of the earth.

In bringing to a close my remarks on the elementary stage of geographical teaching, let me allude to one great advantage which the method of instruction here advocated seems to me to possess. In too many cases the education of the young never advances much beyond the elementary stage. If the geography-lessons have consisted of mere pages of definitions and statistics mechanically learned by rote, they are pretty sure to be soon in great part forgotten, and they leave little or no permanent influence behind them. But if such a system as I have sketched be followed, a lasting benefit can not but remain on the minds and characters of the young learners, even though most of the facts that were familiar enough at school should eventually slip out of their memory. Trained to use their eyes, and to reflect upon what they observe, they start in the race of life with those faculties quickened that tell powerfully on success. They are furnished, too, with a source of perennial pleasure in that capacity for the perception and enjoyment of Nature which these early lessons will have fostered.

Fully to discuss advanced geographical education as it deserves would require an ample and exhaustive treatise. This it is no part of my present plan to attempt. What I wish to do is rather to show how the same guiding ideas may be pursued from the elementary into and through the advanced stage. The latter is broadly characterized by the use of class-books or readers, by the practice of written exercises and essays, and by greater precision, detail, and breadth in the manner of treatment. The line to be pursued will largely depend upon the individual predilections of the teacher himself. In some cases the historical, in others the literary, in others the scientific aspect will be most congenial. It is well that insight into each of these sides of geography should be gained by the pupils. But, above all, the instruction must be earnest and thorough. I come back once more to the idea expressed at the beginning of these chapters that, in the higher stages as well as in the lower, the success of the teacher of geography depends upon his own firm grasp of his subject, upon the living interest he takes in it, and upon the sympathy which he can awaken in the minds and hearts of the young.

A KITCHEN COLLEGE.

By H. BROOKE DAVIES.

KITCHEN College! Well, why not? We have a College of Music, of Surgeons, of Physicians, of Preceptors; why not a College of the Kitchen?

It seems a little absurd at first sight, and yet the only absurdity is, that no one ever thought of it before. For many years the servant-grievance has been before the public. The scarcity and inefficiency of domestic servants have been talked about till we are almost as weary of the subject as of our incapable cooks and house-maids, but nothing seems to have been done to remedy the evil; there has been no improvement except in wages, for, no matter how incompetent the servant may be, she demands and gets high wages, and gives very general dissatisfaction.

I do not mean to touch here on the facilities offered of late years by classes and schools of cookery—doubtless servants can learn much from a course of clever practical lectures—but I would venture to point out that in the majority of cases the persons attending the classes are not servants, but ladies—mistresses in many instances—who go with the praiseworthy intention of learning how to be practical cooks by seeing a practiced instructor roll out pastry, or bake fancy bread in a gas-stove, and then go home and attempt to teach their own cooks; the second-hand instruction frequently taking a negative form, such as, "Cook, that's not the way to make puff pastry, that's not the way to make a custard, or truss a chicken"; the mistress herself having only a very indistinct recollection of what *is* the way.

However much good the schools and cooking-classes may have done, they do not seem to have reached the real root of the domestic-servant difficulty; they have caused no perceptible improvement in servants as a class. Servants are still scarce and unsatisfactory, and there is still the same evident distaste for service among the young women of the working-classes from which we naturally expect to draw our supply. Business of any sort, no matter how unhealthy, precarious, fatiguing, and unremunerative, is preferred to domestic service. A girl will work twelve hours a day and half starve rather than become a house-maid or kitchen-maid, with good food, a comfortable home, and comparatively easy work.

Now, there must be a strong reason for this very wide-spread dislike for service. It is not the love of personal liberty and feeling of independence. No working-woman in the world has less liberty, independence, and comfort than the out-of-door business girl in London. She has to serve not one but many masters; her work gives her neither time for pleasure nor means of enjoyment; her life is one long round

of toil, the only variation being from seams to button-holes, from button-holes to seams, yet she clings to "business" with the strongest tenacity! Why? In the first place, she thinks it respectable; "business" is such a delightfully vague term! It may mean anything. But "service," there is no mistaking the meaning of that word. "Only a servant" is considered the most contemptuous designation. To an uneducated and untrained girl the rules and regulations of service seem very rigid. Service entails neatness, order, politeness, industry, truth, honesty, morality—in short, all the qualifications that go to form a good woman and a good citizen; and where, we may reasonably ask, are young women to acquire all those good qualities before going to service? Failing in them, they fail to give satisfaction to the employer, and hence the everlasting complaints. Besides considering it a disgrace to be a servant, girls have an idea that in domestic service there is no chance of "getting on," while "business" of any sort is full of possibilities; and a third and prevalent objection is that they lose all opportunity of *bettering* themselves by marriage—their prospects are limited strictly to their own class. Those are the weightiest objections young women have to service, and it must be confessed they are not entirely unfounded. No doubt there has been much done of late years to help servants, both physically and morally, but I am not aware that anything has been attempted from a sociological point of view; their position is in many respects worse than it was a hundred years ago. Then, though a servant was ill-paid and more frequently not paid at all, there were compensations, there existed a certain amount of intimacy between master and man, mistress and maid; there were kindly feeling, interest, confidence on the one side, fidelity on the other, the servant was not unfrequently the counselor, and very generally the companion of the master, and took a keen personal interest in all his affairs. Now there are mistrust and suspicion on both sides; the maid thinks the mistress makes it the pastime of her idle moments to worry and find fault with her, while the mistress believes the maid's chief pleasure in life is to cross and annoy her; both misunderstand each other, and the result is mutual discomfort. Without exactly wishing to recall the days of "Caleb Balderstone," one can not help desiring a better feeling between persons who have to live in such very close contact as mistresses and servants. In no other calling whereby a woman earns her bread is she brought into such strictly personal relations with her employer as in service; under no other circumstances is an employer bound to be so careful in investigating the character of the person employed. Our children, at the most tender and impressionable age, are left almost exclusively to the care of servants; our food, on which so much of the health and happiness of our lives depend, is entirely at their mercy. We intrust them with everything we value most, with no better guarantee of their efficiency than the word or the letter of a

complete stranger. In short, we expect a great deal from our servants, and it is reasonable to ask, What do we give in return, what have we ever done for a class on whom we are so dependent, what effort has been made to raise the tone of service, what inducements are offered to respectable young women to enter the ranks? None, or comparatively none! High wages do not prove a sufficient attraction; in no case is the remuneration high enough to secure a competence for old age, without many, many years of toil; there are no fortunes to be made, no special advantages even to be gained, by special skill or integrity. An extravagent, inefficient cook gets as well paid as a capable, economical one, specially among the middle classes, who can not afford to pay for the very best service.

Most people will admit that average servants of late years have deteriorated, partly owing to the fact that they are drawn from an inferior class, and partly because in the terrible march of mind of the last twenty years they have been left behind, their position as a class absolutely ignored; though their failings are ever before us, nothing has been done for their improvement. In one respect the middle classes are unfortunate, they have to suffer for the faults of the upper classes; the kitchen-maid of Belgrave Square becomes very often the cook of a less aristocratic neighborhood, and the waste and extravagance permitted in the kitchen of a rich man are ruinous in the professional man's semi-detached villa, and the cook gets blamed for what, after all, is only the result of improper training. In short, at the present time servants are either badly trained or not trained at all, and therefore we want a Kitchen College.

In other words, we want a thoroughly organized and recognized center, school, college—the name is immaterial—where servants can study and pass such an examination and gain such a certificate as will be a proof of skill and competence not only in one special department, but of general capacity and respectability; that qualifications should be given according to merit; and that the institution should be so managed that a woman would feel as proud of a degree from the "College for Domestic Servants" as from any other college open to women. Cooks, house-maids, parlor-maids, and nurses have all well-defined duties, and a competitive examination is the best method of testing their skill. A nurse frequently knows less about children than any other living creature; she has the haziest ideas about draughts, the most supreme contempt for ventilation, and firmly believes a baby never cries unless it is hungry, and forthwith gives the inevitable bottle, frustrating Nature's efforts to exercise and expand the lungs. A general servant who can cook tolerably and knows a little about housework is the exception; as a rule, she is deplorably ignorant of both. Up to the present a good character has been the only guarantee of efficiency, but it is clear that it is by no means an infallible test; a servant that one mistress may have thought satisfactory may prove

quite the reverse to another. But a trained and certificated servant, who knows her work and does it, would be in a position to ignore fault-finding, or, still more satisfactory, not deserve it, she would be less liable to dismissal for imaginary faults, and she would be to a great extent independent of "characters." As it is, the domestic servant is a sort of shuttlecock tossed from one mistress to another, leaving a different impression on the mind of each. In short, the servant has no standing, no ideal of excellence, no ambition; her life is monotonous and often sordid in its details, her mental and social condition are both uncared for. Surely this ought not to be, and the wives, mothers, and daughters of England should consider it. We live with our servants as if they were aliens, and then wonder they do not serve us with love and gratitude.

It may be objected that training, general education, and the granting of degrees would make a class already difficult to deal with still more so, and that servants would consider themselves the equals of their employers. I think the effect would be just the reverse: a sensible and liberal education would teach women not only what is due to themselves, but what is due to others; and a feeling of independence that the thorough knowledge of his business gives to every worker in every craft would make servants much less suspicious and less resentful. Honest service without servility, cheerful politeness without undue familiarity, cleanliness, economy, and truth, are what we most desire in our domestics; and without education and training how can we reasonably hope to get them? It may be argued against this college scheme, that the effort made years ago to induce better-class women to enter servitude under the name of "lady-helps" proved a failure. A little reflection would have shown that it could not have proved anything else. The lady-help was an artificial growth, and could not possibly meet a real want. We do not want ladies to become servants, neither their habits nor instincts fit them for the occupation: pride and prejudice, sensitiveness, and I might add ignorance, are bad foundations; but it may not be *too Utopian* to hope that servants may become more like ladies, or at least that the ignorant, slipshod, sullen "slavey" who works without hope, and idles without enjoyment, may disappear from among us, and that the time is not far distant when a domestic servant can hear herself spoken of as such, if not with honest pride, at least without shame or discontent.

Therefore, we want a Kitchen College for women, not a school of cookery or conglomeration of unorganized "classes," but a school of everything a servant ought to know; a school or college with exhibitions and scholarships and diplomas, with clever lecturers, and clear, simple text-books, and fees that will come within the means of women who have to work for their daily bread.

The starting and conducting of such a college ought to be woman's work; women suffer most from the ministrations of inefficient ser-

vants, women benefit most by the attention of good ones; and I have no doubt that there are in England women enough—generous, warm-hearted, thoughtful women—to found such an institution; women enough, from the very highest lady in the land, down to the poorest mother of a family, waited on by a nameless little maid-of-all-work from St. Luke's, to stretch out a helping hand to their sisters in service, and give them what every woman has a right to, the means of improving their social standing.

One word more: Kitchen College must be no charity. To make it a success, it must be as much a national institution as the University of Oxford; its degrees, certificates, and prizes must be worked for, fought for, and won, by the most deserving, not as an "imperfect favor, but a perfect right."—*Nineteenth Century.*

WHAT AMERICAN ZOÖLOGISTS HAVE DONE FOR EVOLUTION.*

By Professor EDWARD S. MORSE.

II.

UNDER geographical variation many interesting facts have been added since Professor Baird, Dr. Allen, and Mr. Ridgway published their capital discoveries calling attention to the variations observed in birds and mammals coincident with their latitudinal range. William Bartram, grand-nephew of the famous botanist John Bartram, alludes to the effect of climate in modifying species. In speaking of birds he says, "The different soil and situation of the country may have contributed in some measure in forming and establishing the difference in size and qualities betwixt them."

Dr. J. A. Allen† shows marked geographical variation among North American mammals in respect to size. He shows that—"1. The maximum physical development of the individual is attained when the conditions of environment are most favorable to the life of the species. 2. The largest species of a group (genus, sub-family, or family, as the case may be) are found when the group to which they severally belong reaches its highest development, or when it has what may be termed its center of distribution. 3. The most typical or most generalized representatives of a group are found also near the center of distribution, outlying forms being generally more or less aberrant or specialized." In the study of the eggs of birds of the same species, North and South, Dr. Allen shows that in the South the

* Address of the retiring President of the American Association for the Advancement of Science, delivered at the New York meeting, August 10, 1887.

† "Bulletin of the United States Geological Survey of the Territories."

eggs are less in number and smaller in size.* Mr. Robert Ridgway† calls attention to the geographical variation observed in *Dendrœca.*

The same author,‡ in a discussion of a paper by Salvin in the "Transactions of the Zoölogical Society of London," on the relationships between the birds of Guadeloupe and the mainland, refers to the present genesis of species, and points to the increase in size of the bill and feet, the shorter tail and wings and darker colors, as characterizing them.

Dr. E. C. Coues,§ in his studies regarding geographical variation in color among North American insectivorous mammals, says: "My studies up to the present go to show a very interesting parallelism with the state of the case I have determined for other small mammals, notably the mice and gophers, and which my friend Mr. Allen has admirably brought out in his studies of the squirrels. In some cases I find almost identical effects of climatic or other conditions upon the shrews and the mice of particular localities, by which they both acquire the same *facies loci.* Present indications are that the normal variability of the shrews in size, shape, and color is not less than has been determined to hold good in various other families of mammals." In this memoir Dr. Coues has verified a curious fact, first pointed out by Professor Baird, of the modifications of the premolar dentition which the Western species collectively, as compared with the Eastern, have undergone: "A striking peculiarity of all the Western species, no matter how diverse in other respects, is to have the 'third premolar' decidedly smaller than the 'fourth,' while in all the species east of the Rocky Mountains (with one possible exception) the same tooth is as large as, or larger than, the other. Of the fact there is no question; it may be observed in an instant, and is unmistakable. Its significance is another thing. Some of the Western species are scarcely distinguishable if at all from their respective Eastern analogues, except by this character, and they all show it."

Professor A. Hyatt‖ finds in sponges geographical variation in color, referring to similar features in birds as recorded by Baird and others.

Professor David S. Jordan,^ in a paper on the distribution of fresh-water fishes, presents a concise series of propositions which govern these animals in the United States. They all point to the action and importance of physical conditions as governing distribution. Space will permit only the quoting of the last proposition, which is a summing up of his conclusions: "The distribution of fresh-water fishes

* "Bulletin of the Nuttall Ornithological Club," vol. i, p. 74. † Ibid., p. 81.

‡ Ibid., vol. ii, p. 58.

§ "Bulletin of the United States Geological Survey of the Territories," vol. iii, No. 3, p. 635.

‖ "Memoirs of the British Society of Natural History," vol. ii, part iv.

^ "American Naturalist," vol. xi, p. 607.

is dependent on (*a*) fresh-water communication; on (*b*) character of stream, that is, of water, as to purity, depth, rapidity, vegetable growth, etc.; on (*c*) the character of the river-bed, as to size, condition of bottom, etc.; on (*d*) climate, as determined by latitude and by elevation above the sea; and, finally, on (*e*) various unknown factors arising from the nature or the past history of the species in question, or from the geological history of the rivers."

Dr. James Lewis * has observed a not unlike condition of things in the distribution of the fresh-water mussels of Ohio and Alabama. By a series of tables he calls attention to what he believes is the occurrence of identical and equivalent species in the two systems of drainage, and suggests that, owing to the number of varieties characterizing the *Unionidæ* they may be identical. This author † has also studied the genus *Io* and its habits, and notices its variation coincident with latitude and temperature.

Dr. R. E. C. Stearns,‡ in a paper on the circumpolar distribution of certain fresh-water mussels and the identity of certain species, unites many hitherto recognized species of *Anodonta*. Dr. J. G. Cooper,* in a study of the fossil and sub-fossil land-shells of the United States, sees the strongest evidence in support of the idea that the older ones are the direct ancestors of certain forms living to-day.

Mr. R. P. Whitfield ‖ read a paper before the Boston Society of Natural History, showing changes produced in *Limnæa megasoma* when kept in an aquarium. Having at the outset three specimens, two of them finally died, and from the remaining one eggs were produced, presumably unimpregnated. These eggs hatched, and from these the next year came a second generation, which in turn produced a third generation the following year. The animal of *Limnæa* is hermaphrodite. Nevertheless, besides diminished size in the shell, it was observed that the male parts had disappeared, and the liver had become considerably reduced in size. He shows that a dicœcious species had in a short time become moncœcious as a result of the new physical conditions of life in the constricted quarters of an aquarium.

An instructive paper by D. W. D. Hartman,△ on the genus *Partula* of the Hawaiian Islands, shows in the most convincing manner the effect of environment in modifying the species. He finds a common occurrence of hybrids among certain forms, the result of the union of proximate species. This hybridization occurring even between arboreal and ground species, Dr. Hartman states that "gravid females are often washed by heavy rains from a favored position to drier levels, where after a few generations the progeny become depauper-

* "Proceedings of the Philadelphia Academy of Natural Sciences," 1877, p. 26.

† "American Naturalist," vol. x, p. 321.

‡ "Proceedings of the California Academy of Natural Sciences."

* Ibid., vol. i, No. 4, p. 235.

‖ "American Naturalist," vol. xiv, p. 51.

△ Ibid., vol. xvi, p. 581.

ated, and so stunted in size as to be mistaken for distinct species." Dr. W. H. Dall,* in some general considerations regarding the environment of the deep-sea mollusks, as compared with the shallow-water and littoral forms, shows how much the littoral forms have to contend with in the struggle for existence as compared with the deep-sea forms, and the delicate sculpture and extreme fragility of many of the shells occurring in the deeper abysses of the sea are to be explained on the ground of their habitat. Dr. Carl F. Gissler† has presented some interesting evidences of the effect of chemico-physical influences in the evolution of the branchiopod crustaceans.

The effect of mechanical strains as producing like morphological effects has been treated in a masterly way by Dr. John A. Ryder.‡ He cites the vertebral axes of turtles and extinct armadillos, also the sacra of birds and mammals, and says: "These observed coincidences, it is believed, are neither accidental, nor designed by an active cause external to these organisms or their cosmic environment. I would rather believe that the structures, so far as they have been evolved in parallel or similar ways, are the results of like forces conditioning growth and nutrition in definite modes and determinate directions. The manner of incidence of the modifying forces being in all cases determined by the voluntary actions of the organisms, the actions in turn are determined by the degree of intelligence of the animal manifesting them."

In considering the "Laws of Digital Reduction,"# Dr. Ryder gives a concise presentation of the various groups of animals, showing in each the line of mechanical strain in the extremities and its correlation with the increased development of those digits bearing this strain, and the consequent reduction or atrophy of those digits out of this line. These considerations led him to the following conclusions:

"1. That the mechanical force used in locomotion during the struggle for existence has determined the digits which are now performing the pedal function in such groups as have undergone digital reduction.

"2. That where the distribution of mechanical strains has been alike upon all the digits of the manus or pes, or both, they have remained in a state of approximate uniformity of development.

"3. It is held that these views are Lamarckian and not Darwinian—that is, that they more especially take cognizance of mechanical force as a mutating factor in evolution, in accordance with the doctrine of the correlation of forces."

Dr. Ryder further says, "It seems a most convincing proof of the doctrine of descent to find man an instance of the same kind of

* "Bulletin of the Museum of Comparative Zoölogy," vol. xii, No. 6, p. 183.

† "Proceedings of the American Associated Antiquarian Society," vol. xxix, p. 557.

‡ "American Naturalist," vol. xii, p. 157.

Ibid., vol. xi, p. 603.

specialization determined by the manner of the distribution of strains as is so often found among the lower groups, such as the horses, sloths, jumping-mice, and even-toed ungulates."

In another memoir* Dr. Ryder considers the mechanical motion in forming and modifying teeth. Considering first the simplest form of movement in the mammal's jaw, opening and closing, without fore and aft or lateral movement, he shows the successive changes going on coincident with the more complex movements of the jaw, and that the enamel foldings, ridges, crests, etc., have apparently been modified in conformity with the ways in which the force used in mastication was exerted.

Professor A. Hyatt,† in an exhaustive study of the Planorbis of Steinheim, shows among other things the effect of gravitation as accounting for the form of the mollusk-shell, citing examples from all the classes, and even drawing examples from other subkingdoms to support his views.

Professor E. D. Cope,‡ in a memoir on "Archæsthetism," considers the hypothesis of use and effort, the office of consciousness, etc. He attempts to show that consciousness is primitive and a cause of evolution. He sustains his thesis by a series of arguments which, if not beyond my grasp, would be too extensive to present here. I can only repeat the regret I expressed in the Buffalo address, namely, that neither Professor Cope nor Professor Hyatt has yet been induced to present to the public an illustrated and simple outline of their theories. Such a demonstration, I am sure, would be acceptable not only to the public but to many scientific students as well. While these two eminent naturalists believe fully in the derivative theory, they insist that Darwin's theory is inadequate to explain many of the phenomena and facts which they encounter in their studies. Darwin has distinctly said in his first edition of the "Origin of Species," "I am convinced that natural selection has been the main but not the exclusive means of modification"; and in his sixth edition of the same work, in quoting these words, he laments that he is still misunderstood on this point. The theory of acceleration and retardation of these authors is, if I understand it rightly, a very plain case of natural selection. It was inevitable that those individuals that matured the quickest were better prepared to defend themselves, were quicker in the field, were able to give their offspring an earlier start in the season, were in every way more fitted to survive than those which matured later. It is assumed that this is a law, when, to my mind, it seems the simplest result of natural selection. Instead of overriding it, it is only a conspicuous result and proof of it.

* "Proceedings of the Philadelphia Academy of Natural Sciences," 1878, p. 45.

† "American Naturalist," vol. xvi, p. 441. Also "Proceedings of the American Associated Antiquarian Society," vol. xxix, p. 527.

‡ "American Naturalist," vol. xvi, p. 454.

A parallel case may be seen in the increase in size of the brain in the vertebrates, and conspicuously in the higher vertebrates, since their first appearance in geological history. The individual brain clearly varies in size, and it does not require a great effort to perceive how in the long run the greater brain survives in the complex struggle for existence. Associated with the greater development, parts that were freely used for locomotion before are now compelled to perform additional service, and through the law of use and effort, which all admit as an important factor, organs are modified in structure, the anterior portion of the body assumes a new aspect; and it was on the character of these parts and aspects that Professor Dana was led to formulate his comprehensive and ingenious principle of cephalization. It is a result and not a cause. And so I believe, though with great deference to Cope and Hyatt, that the laws of acceleration and retardation, exact parallelisms, inexact parallelisms, and still more inexact parallelisms, and many other laws and theories advanced by these gentlemen, are not causes but effects, to be explained by the doctrine of natural selection and survival of the fittest.

The connecting links and intermediate forms which the skeptical public so hungrily demand are continually being discovered. Great gaps are being closed up rapidly; but the records of this work, being published in the journals of our scientific societies, are hidden from the public eye as much as if they had been published in Coptic. So rapidly have these missing links been established that the general zoölogist finds it difficult to keep up with the progress made in this direction. He can hardly realize the completion of so many branches of the genealogical tree.

Professor Cope,* who has accomplished so much in this direction, says: "Those who have, during the last ten years, devoted themselves to this study, have been rewarded by the discovery of the course of development of many lines of animals, so that it is now possible to show the kind of changes in structure which have resulted in the species of animals with which we are familiar as living on the surface of the earth at the present time. Not that this continent has given us the parentage of all forms of animal life, or all forms of animals with skeletons, or vertebræ, but it has given us many of them. To take the vertebrata, we have obtained the long-since extinct ancestor of the very lowest vertebrates. Then we have discovered the ancestor of the true fishes. We have the ancestor of all the reptiles, of the birds, and of the mammals. If we consider the mammals, or milk-givers, separately, we have traced up a great many lines to their points of departure from very primitive things. Thus we have obtained the genealogical trees of the deer, the camels, the musk, the horse, the tapir, and the rhinoceros, of the cats and dogs, of the lemurs and monkeys, and have important evidence as to the origin of man."

* "Popular Science Monthly," vol. xxvii, p. 605.

In 1874 he predicted that the ancestor of all the mammals would be a five-toed, flat-footed walker, with tubecular molar teeth, or in exact language, a pentadactyl, plantigrade bunodont. Seven years after, he obtained evidences that such a type of mammals abounded in North America during the early Eocene Tertiary period. Professor Cope,* in his phylogeny of the camels, shows a remarkable parallel to that of the horse, both forms appearing in the Lower Eocene. Mr. Eugene N. S. Ringueberg† believes he has found in a thin layer of limestone at Gasport, New York, a deposit in which a number of forms of brachiopods seem to present the intermediate stages between certain brachiopods common to the Clinton and the group of rocks immediately above. While the majority of species in this deposit belong to the Niagara, there are among the fossils met with three species of brachiopods which were supposed to have passed out of existence with the Clinton. He finds in this bed thirty-two forms peculiar to the Niagara, eleven common to Niagara and Clinton, three belonging to the Clinton, and two characteristic forms of the transition group. Many of these show intermediate characters.

Professor H. S. Williams,‡ in his paleontological studies of the life-history of *Spirifer lævis*, in which he traces the ancestral line of this creature, says: "Whatever theoretical description we may give to species, here are, in the first place, an abundance of individual organisms whose remains are found in the Upper Silurian rocks of Europe, Great Britain, and America, presenting a few clearly marked, distinctive characters, which are found variously developed in the individual forms, but so grading in the various varieties as to cause careful naturalists to associate them as varieties of a single species."

Dr. C. A. White,* in his comparisons of the fresh-water mussels and associated mollusks of the Mesozoic and Cenozoic periods with living species, expresses his belief that the present *Unios* of North America, particularly those forms allied to *Unio clavus*, have come down in an unbroken line from the Jurassic and possibly from earlier times. He shows that thus far all the fossil *Unios* have been obtained from lacustrine deposits, none of these beds being distinctly fluviatile. He furthermore calls attention to the fact that "these lacustrine formations are of very great extent in Western North America, and, without doubt, the lakes in which they were deposited were caused by encircling bands of rising land during the elevation of the continent. These great landlocked waters were at first brackish, but finally became, and for a long time remained, fresh, continuing so until their final desiccation." From this commingling of salt and fresh water he justly assumes that many modifications arose in the forms of *Unios*

* "American Naturalist," vol. xx, p. 611. † Ibid., vol. xvi, p. 711.

‡ "American Journal of Science and Arts," vol. xx, p. 456.

* "Bulletin of the United States Geological Survey of the Territories," vol. iii, No. 3.

subjected to these influences, and hence has resulted a variety of forms which have gone on continually widening to the present day.

Professor A. G. Wetherby,* in a paper on the geographical distribution of certain fresh-water mollusca and the possible cause of their variation, shows the paucity of forms of *Unionidæ* on the Pacific and Atlantic coasts as compared to the richness and profusion of those forms in the central portion of the continents. He remarks also on the absence of the family *Strepotomidæ*, east of the Alleghanies. He assumes that the first fresh-water forms were lacustrine. He points out the well-known geological fact of large inland inclosures and their subsequent drainage, and shows the vicissitudes which must have been encountered by species in the variety of physical conditions implied by these changes. In this connection I may be permitted to call attention to the fact that at a meeting of this Association, at Hartford, in 1874, I made a communication on the origin of the North American *Unionidæ*, in which I urged some of the points made by Dr. White and Professor Wetherby.†

Dr. Thomas H. Streets,‡ in studying the immature plumage of the North American shrikes, was much struck with the close resemblance between the plumage of the young of *Sula cyanops* and the adult plumage of another species. Recalling a generalization made by Darwin, that "when the young differs in color from the adult, and the colors of the former are not, as far as we can see, of any special service, they may generally be attributed, like various embryological structures, to the retention by the young of the characters of an early progenitor." He then shows the gradation between the several species of shrikes from this standpoint, and traces their descent from a common ancestor.

* "Journal of the Cincinnati Society of Natural History," vol. iii, p. 357, and vol. iv, p. 156.

† The following is a brief abstract which was published in the Hartford "Courant," August, 1874: "Mr. Morse, in explaining the origin of the North American *Unionidæ*, did not pretend to point out the absolute line of descent in these forms, but wished to call attention to some curious features in the possible derivation of the fresh-water families of mollusks from cognate genera living in salt water. It is observed, first, that the few families of fresh-water mollusks are intimately related to those forms which live in the sea between high and low water mark, and those which can withstand the influence of brackish water. He cited certain families of fresh-water mollusks which are so closely related to tidal forms as hardly to be distinguished from them. . . . In explaining the immense number of species of fresh-water mussels in America compared to the very few forms in Europe, we might look to an explanation of this feature in the past geological history of the two continents.

"In Europe there have been no great inland seas, while in America its past history shows the inclosing of large tracts of water in which freshening from brackish water went on, and, while many forms succumbed to these changed conditions, only those forms survived which resemble certain littoral species. And with the curious modifications that must have taken place in these changed conditions, one gets a possible explanation of the great variety of mollusks in our Western rivers."

‡ "American Naturalist," vol. xvii, p. 389.

Professor S. A. Forbes,* in a study of the "Blind Cave Fish and their Allies," is led to review the conclusions reached by Professor F. W. Putnam in his interesting papers on the subject. Professor Putnam brought forth a number of arguments which seemed to him to militate against the views urged by evolutionists that their peculiar characters were adaptive and the result of their cave-life. He was led to the conclusion that the absence of light had not brought about the atrophy of the eyes, the development of special sense-organs, and the bleaching of the skin. In referring to another cave-fish, Chologaster, with eyes fully developed, it was urged that the argument in regard to eyeless fishes could have no weight. In response to this it was answered that possibly Chologaster had not been subjected to subterranean influences long enough to be affected, and this objection was anticipated by urging that we have no right to assume that Chologaster is a more recent inhabitant of the caves, until proved.

The discovery of another species of Chologaster, taken from a spring at the base of a limestone cliff in Illinois, has given Professor Forbes an opportunity to make careful comparisons with the cave Chologaster. He says in regard to it, "The most important and interesting peculiarity of this species indicates a more advanced stage of adaptation to a subterranean life than that of its congeners." Referring to Professor Putnam's arguments, Professor Forbes says that "the discovery of a species of Chologaster, which frequents external waters, of an immediate subterranean origin, supplies all needed proof that the genus either has a shorter subterranean history than Amblyopsis, or, at any rate, has remained less closely confined to subterranean situations; and that in either case the occurrence of eyes, partial absence of sensory papillæ and persistence in color, are thus accounted for consistently with the doctrine of 'descent with modification.'" In this connection it may be of interest to read the curious fact recorded by Mr. S. H. Trowbridge,† of the discovery in the Missouri River of a shovel-nosed sturgeon which had the skin growing over the eyes, completely inclosing them. Dr. S. H. Scudder,‡ in a memoir read before the National Academy, brings forward evidence to show that ordinal features among insects were not differentiated in Palæozoic times, but that "all Palæozoic insects belonged to a single order which, enlarging its scope as outlined by Goldenberg, we may call Palæo-dictyoptera; in other words, the palæozoic insect was a generalized hexapod, or more particularly a generalized Heterometabolon." In a memoir on the earliest winged insects of America, embracing a re-examination of "The Devonian Insects of New Brunswick," published by the author, Dr. Scudder replies to some sharp criticisms and objections made by Dr. Hagen, and pertinently says, that "there is no evidence—but the contrary—that Dr. Hagen in his investigations

* "American Naturalist," vol. xvi, p. 1. † "Science," vol. iii, p. 587.

‡ "American Naturalist," vol. xix, p. 877.

uses the 'theory of descent' as a working hypothesis, without which no one studying any group of animals in the period of its rise and most rapid evolution can expect to do otherwise than stumble and wander astray. To refuse it is to merit failure."

Professor J. S. Kingsley, in his study of Limulus, regards it as an Arachnid, but states that its ancestors take us back to a time when the distinctions between the Crustacea and Arachnida were far less marked than now.

Dr. A. S. Packard,* in a paper on the "Genealogy of the Insects," shows by means of a "genealogical tree" the descent of the class from the Thysanura, with some hypothetical creature not unlike Scolopendrella, as the probable stem-form of the hexapods. It is through the resemblance the larvæ of the different orders of insects bear to various members of the Thysanura that this scheme is justified. It may not be out of place to say here that the use of the "genealogical tree," in suggesting the probable line of descent of various allied groups, has been severely condemned by some as leading to no practical good in classification. It seems to me, however, the only clear scheme for the proper working out of the ascertained or hypothetical relationships of animals; it is thought-exciting, its very attitude provokes studious inquiry and suggestive inferences. It may be called the modern tree of knowledge.

The modern genealogical tree as used by the biological student (and as well by the ethnologist, philologist, and others) is a graphic diagram of the relationships between groups as understood by the projector, and, as such, is a most commendable and useful method with which to illustrate his meaning. With additional knowledge one can see at a glance the points that need strengthening, and he can pare, prune, or even graft new fruits on the old stock, or, if it is rotten at the trunk, cut it down altogether. These trees have always been in vogue with the older naturalists, only, in the old style of arboriculture, the trunk was always kept stiffly vertical, while the branches were bent down and trained horizontally, being flimsily attached to the main stem by printers' devices of long and short brackets. In this attitude it reminded one of the dwarfed and deformed trees of the Chinese, and very properly typified the dwarfed and deformed way of looking at classification.

Never was the provisional use of a genealogical tree more completely justified than in a memoir by Dr. Alexander Agassiz† on the "Connection between Cretaceous and Echinid Faunæ." He certainly speaks in no uncertain terms when, in considering the Spatangoids of the chalk, he says, "They lead us directly through the *Palæostominæ* and the *Collyritidæ* to the *Ananchytidæ* which have persisted to the present day," and other relationships of the same nature are repeated-

* "American Naturalist," vol. xvii, p. 932.

† "American Journal of Science and Arts," vol. xxiii, p. 40.

ly urged as would not only justify the use of the genealogical diagram against which he so strongly inveighed in his admirable address before this Association at the Boston meeting; but had he adopted this method, a much clearer view of the very points he wished to emphasize would have been afforded his readers.

It was the strictures of Agassiz above referred to that led Professor W. K. Brooks* to write a paper on the subject of "Speculative Zoölogy," in which he most earnestly and ably defends the use of genealogical diagrams, and justly says: "If phylogenetic speculations retard science, speculations upon homology must do the same thing; and the only way to avoid danger will be to stick to facts, and, stripping our science of all that renders it worthy of thinking men, to become mere observing machines."

Since 1876 Professor Marsh and Professor Cope have in various journals and Government publications presented the results of their discoveries of the past vertebrate life of North America. The General Government has published the two great monographs of Professor Marsh on the Dinocerata, an extinct order of gigantic mammals, and the Odontornithes, an order of extinct toothed birds, as well as Professor Cope's great volume on the Tertiary Vertebrata, besides other memoirs by the same authors. Space will forbid more than a passing allusion to the varied and remarkable additions to our knowledge of extinct vertebrate life made by these naturalists.

Had a moiety of the work accomplished by these investigators been known to Geoffroy Saint-Hilaire, the theory of descent would have been established long before Darwin, though to Darwin and Wallace belongs the full credit of defining the true cause. Leidy, Marsh, and Cope have not only brought to light a great number of curious beasts, many of them of gigantic and unique proportions, but forms revealing in their structure the solution of many morphological puzzles, and throwing light on the derivation of many obscure parts.

The discovery in the Western tertiaries of multitudes of huge and monstrous mammals and, earlier still, of gigantic and equally monstrous reptiles, naturally led at once to an inquiry as to the cause of their extinction. "Nothing can be more astonishing," says Professor Joseph Le Conte,† "than the abundance, variety, and prodigious size of reptiles in America up to the very close of the Cretaceous, and the complete absence of all the grander and more characteristic forms in the lowest Tertiary; unless, indeed, it be the correlative fact of the complete absence of mammals in the Cretaceous, and their appearance in great numbers and variety in the lowest Tertiary. . . . The wave of reptilian evolution had just risen to its crest, and perhaps was ready to break, when it was met and overwhelmed by the rising wave of mammalian evolution." In this paper of Le Conte's, which is entitled

* "Popular Science Monthly," vol. xxii, pp. 195, 364.

† "American Journal of Science and Arts," vol. xiv, p. 99.

"On Critical Periods in the History of the Earth and their Relation to Evolution: and on the Quaternary as such a Period," may be found an excellent rejoinder of Professor Clarence King's lecture before the Sheffield Scientific School on the subject of "Catastrophism and Evolution."

Among the most interesting discoveries connected with these creatures is the determination by Professor Marsh* that these early mammals, birds, and reptiles had brains of diminutive proportions. He says in regard to the order Dinocerata, a group of gigantic mammals whose remains have been found in the tertiary deposits of the Rocky Mountain region, that they are the most remarkable of the many remarkable forms brought to light. The brain of these creatures was remarkable for its diminutive proportion. So small, indeed, was the brain of *Dinoceras mirabile*, that it could "apparently have been drawn through the neural canal of all the presacral vertebræ." In alluding to the successive disappearance of the large brutes, the cause is not difficult to find: "The small brain, highly specialized characters, and huge bulk, render them incapable of adapting themselves to new conditions, and a change of surroundings brought extinction. The existing proboscidians must soon disappear, for similar reasons. Smaller mammals, with larger brains, and more plastic structure, readily adapt themselves to their environment, and survive, or even send off new and vigorous lines. The Dinocerata, with their very diminutive brain, fixed characters, and massive frames, flourished as long as the conditions were especially favorable; but, with the first geological change, they perished, and left no descendants." Professor Marsh says that the brain of Dinoceras was in fact the most reptilian brain in any known mammal.

Professor Cope,† in describing the brain of Coryphodon from the deposits of New Mexico, says: "The large size of the middle brain and olfactory lobes gives the brain as much the appearance of that of a lizard as of a mammal." This is one of the lowest mammalian brains known. There are others from the Lower Eocene with equally low brains as Arctocyon of Gervais and Uintatherium of Marsh. Cope believes that the type of brain of these early creatures is so distinct as to necessitate the erection of a third sub-class of equal rank with the groups Gyrencephala and Lycencephala, which he would define as the Protencephala. He shows their approximation to reptiles.

Cope‡ refers to Gratiolet as showing that a great development of the olfactory is a character of an inferior type; in fact, the more we ascend into paleontological antiquity, the more we find that the olfactory lobes display a greater development in comparison with the cerebral hemispheres. Dr. B. G. Wilder# has shown that in the lamprey

* "American Journal of Science and Arts," vol. xxix, p. 173.

† "American Naturalist," vol. xv, p. 312. ‡ "National Academy of Sciences," 1876.

"American Journal of Science and Arts."

the only part which can be regarded as a cerebral hemisphere lies laterad of the olfactory lobe. In Dipnoi he finds that the cerebral outgrowth is ventrad. In another paper* he says: "In either of these directions in which what may be regarded as the special organ of the mind is projected among these low or generalized forms, there would seem to be mechanical obstacles to any considerable expansion; but dorsally there is opportunity for comparatively unlimited extension, and it is in this direction that the hemispheres begin to develop in the Amphibia and attain such enormous growth in birds and mammals." How far the small brain and presumably stolid intellects brought about the extinction of the huge tertiary mammals may be better understood by the suggestions offered by Professor A. E. Verrill† in a lecture at Yale College, entitled "Facts Illustrative of the Darwinian Theory." He shows what an important factor parental instinct is in the evolution of species. He regards the lack of parental care "as one of the probable causes, though usually overlooked, of the extinction of many of the large and powerful reptiles of the Mesozoic age and of the large mammals of the Tertiary." He says: "The very small size of the brain and its low organization in these early animals are now well known, and we are justified in believing that their intelligence or sagacity was correspondingly low. They were doubtless stupid and sluggish in their habits, but probably had great powers of active and passive resistance against correspondingly stupid carnivorous species. But unless the helpless young were protected by their parents, they would quickly have been destroyed; and such species might, in this way, have been rapidly exterminated whenever they came in contact with new forms of carnivorous animals, having the instinct to destroy the new-born young of mammals, and the eggs and young of oviparous reptiles. Thus it would have come about that the more intelligent forms, by the development of the parental instinct for the active protection of their young against their enemies, would have survived longest, and therefore would have transmitted this instinct, with other correlated cerebral developments, to their descendants."

Professor John Fiske, in his "Cosmic Philosophy," arrived at a similar conclusion in regard to early man. He showed that, when variations in intelligence became more important than variations in physical structure, then they were seized upon, to the relative exclusion of the latter.

The derivative theory has not only clearly revealed the fact that animals have been derived from pre-existing forms, but it shows even more clearly that organs have been evolved as well. It is difficult, in a general review of this nature, to separate clearly the two classes of facts.

Professor Cope‡ has traced the genesis of the quadritubercular

* "American Naturalist," vol. xxi, p. 546. † "Science," vol. i, p. 303.

‡ "American Naturalist," vol. xvii, p. 407.

tooth in the mammals of the present day. He finds that the type of the superior molar tooth of the mammals of the Puerco epoch was triangular or tritubercular—that is, with two external and one internal tubercle. Of forty-one species of mammals of this epoch all but four of them had this type of tooth. He finds that this tooth exists to-day only in the insectivorous and carnivorous marsupials. In brief, he shows a gradual change taking place from the early primitive type of tooth in the gradual development of another tubercle. The same author,* in defining the characters of an ancient order of mammals, the Amblypoda, says they are the most generalized order of hoofed mammals, being intermediate in the structure of their limbs and feet between the Proboscidia, the Perissodactyla, and Artiodactyla, which fact, together with the small size of the brain, places them in antecedent relation to the latter, in a systematic sense, connecting them with the lower mammals with small and smooth brains still in existence; and in a phylogenetic sense, since they precede the other orders in time, they stand in the relation of ancestors.

Professor Cope,† in a paper read before this Association on the "Classification of the Ungulata," gives special attention to the arrangement and character of the carpal and tarsal bones. He shows that "the weaker structure of the carpus and tarsus appears first in time; that the stronger structure appeared first in the posterior limbs, and that the interlocking structure has greatly multiplied, while the linear has dwindled and mostly disappeared. Here is a direct connection between mechanical excellence and survival."

In the light of Mr. Caldwell's unquestionable determination of the oviparous character of that curious mammal, the duck-bill mole, associated with its known reptilian bearings as deduced from its skeleton and other features, the deductions of Professor Cope‡ regarding the "Relations between the Theromorphus Reptiles and the Monotreme Mammalia" are of great interest.

In the Theromorpha are two divisions, one of which, the Pelycosauria, is limited to the Permian, and of one of this group he makes the following comparisons: "1. The relations and number of the bones of the posterior foot are those of the Mammalia much more than those of the Reptilia. 2. The relations of the astragalus and calcaneum to each other are as in the Monotreme *Platypus anatinus*. 3. The articulation of the fibula with both calcaneum and astragalus is as in the Monotreme order of mammals." In brief, he shows the affinity of this reptile to be with the monotremes, and that the affinities are very important in the light of Mr. Caldwell's researches, and the further fact that the development of the egg is meroblastic confirms, so to speak, the reptilian affinities of the monotremes.

* Wheeler's "United States Geographical Survey," vol. iv, part ii, p. 182.

† "Proceedings of the American Associated Antiquarian Society," vol. xxxi, p. 477.

‡ Ibid., vol. xxxiii, p. 471.

Here, then, are a series of observations by different observers from different standpoints, all telling the same story. Osteologists have long ago pointed out the reptilian affinities of the monotremes from the character of the skeleton. The anatomists in like manner have insisted upon certain reptilian characters as well as avian characters from its internal structure. A trained zoölogist now studies it on the ground, and finds it laying true eggs, a fact that had been insisted upon several times in the present century. More significant still, the study of these eggs shows that they go through a reptilian mode of development. And now the paleontologist brings to light the remains of a reptile from the Permian rocks, and again establishes the same relations.

In this connection the examination by Dr. Henry C. Chapman* of a fetal kangaroo and its membranes is of interest. The fœtus he examined was fourteen days old. He states that it had no true placenta, and says, "If the parts in question have been truthfully described and correctly interpreted, as partly bridging over the gap between the placental and non-placental vertebrates, they supply exactly what the theory of evolution demands, and furnish, therefore, one more proof of the truth of that doctrine."

THE UNHEALTHFULNESS OF BASEMENTS.†

By W. O. STILLMAN, M. D.

IN many American cities basement-houses are quite the rule; and rooms, partly or almost completely below the street-level, are in common use as work and dining rooms, and occasionally for living and sleeping purposes.

A rather casual examination of the standard works, on hygiene, of Parkes, Buck, Wilson, and others, fails to reveal any condemnation of basements, though the dangers arising from damp cellars and foundations are freely discussed. A not unnatural conclusion might be that these eminent sanitarians lived in an air of such hygienic innocence and purity that the possibility of the enormity of basement-living had not occurred to them to be reprehended.

The value of ground-space in modern cities has caused architects to plan for the occupancy of perpendicular space below as well as above the surface of the earth. In very few dwellings are the inhabitants protected from earth-damp, whether a basement or cellar intervenes. Every physician recognizes the dangers arising from damp and cold, not to specify from noxious exhalations, and unhealthy subterranean air-currents. Rheumatism, consumption, malaria, neuralgia, etc.,

* "Proceedings of the Philadelphia Academy of Natural Sciences," 1881, p. 468.

† From a paper read before the Albany County Medical Society, March 23, 1887.

are constantly produced by such conditions. Humanitarians and philanthropists have painted the pitiable horrors of poor wretches living in cellars and dungeons. Are not many of the modern basements practically just as objectionable and injurious as the former?

Modern basements are, first, usually damp. In a clay soil, water is frequently found standing beneath the floor. There is commonly little air-space, the floor being usually laid almost upon the ground. The ground beneath the floor is almost always moist, as far as I have observed in this locality, and this is due to the following facts: 1. It being lower than the street it receives some surface drainage; 2. It often dips far enough down to encounter subsoil saturation, or subterranean streams; 3. Because it is usually improperly drained, if drained at all; and, 4. It is often subject to the leakage of broken or defective drains, cess-pools, etc.

The modern basement is, secondly, in danger of such air contamination as would naturally occur from unimpeded communication, through porous soil, with defective drains, sewer-leaks, and the general subsoil filthiness of a city.

To guard against the undesirable conditions mentioned several things are necessary, and should doubtless be considered in building all basement-houses. First, area-ways, or air-spaces, should be constructed around the outside walls to guard against lateral dampness, and carry off the surface-drainage, which has a tendency to sink down by the outside walls to the foundations. Second, air-spaces should be allowed under basement-floors, and these should be ventilated. Third, damp-proof courses should be laid in all foundation-walls, to prevent the upward spread of moisture throughout the house. An ordinary brick will hold nearly a pint of water. A house not thus protected will always remain damp and unhealthy. Fourth, the entire surface of the ground under a basement-floor should be covered with a layer of concrete, at least six inches thick, and this in turn covered and hermetically sealed, from wall to wall, with a coating of coal-tar or Portland cement. This keeps out vermin as well as damp, and effectually shuts out dangers from leaking sewers or drains. Fifth, the foundations of a house, in a moist soil especially, should be drained. Sixth, the main soil or drainage pipes, which are frequently laid beneath city houses, should not be constructed of tile, brick, etc. With numerous joints, leaks and settlings are apt to occur. Heavy cast-iron pipes are best, as demonstrated by most recent experience.

The above precautions, if not defective, guard a basement against dampness, and also against foul air, coal-gas, effluvia from privy-wells and cess-pools, sewer-gas, and the various exhalations of a not infrequently filth-sodden soil, and it should not be forgotten that an unhealthy basement usually means an unhealthy house. Polluted air is sucked all over the house by the rise of heated air from the basement.

If we must have basements to live in, such safeguards should be

enforced. But, for one, I wish to record my protest against our modern living-cellar. A well-ventilated basement is almost an impossibility from its low level, and it is so difficult to get our ideal conditions perfectly executed, that practically they are seldom met with. I have seen a great many cases of sickness which seemed to me due to basement-living, and many cases of tuberculosis which seemed to have been there developed. The last is particularly noticeable among servant-girls of foreign birth. In the experience of physicians in some sections, it is rare to find a servant-girl living and working in a low basement who has good health, though previous to coming to this country, and being subjected to such conditions, good health is stated to be the general rule. Many people have attacks of sickness, following a time of exposure in a basement, with great regularity.

Would it not be better for house-builders and architects to plan for dwellings built more above-ground? More of a lot has to be sacrificed, but perhaps enough may be saved in healthfulness and stair-climbing to compensate for the loss. City yards are of slight value at best. A good cellar is gained by such a change, and up-stairs dining-rooms and kitchens are not only luxuries, but, it may be argued, almost necessities.

SKETCH OF CHESTER S. LYMAN.

IN the company of Puritans who, in the severe winter of 1635, traveled from Massachusetts Bay through the wilderness and settled at Hartford and Windsor, was Richard Lyman, who had come over from England four years before in the same ship with John Eliot, the Indian Apostle, and who, through his two sons Richard and John, was the ancestor of all the Lymans in America. Nearly two hundred years later, in the little country town of Manchester, ten miles from Hartford, CHESTER SMITH LYMAN, his eighth lineal descendant, was born January 13, 1814, the son of Chester and Mary Smith Lyman.

He had in his boyhood only the advantages of a common country school, and, like other country boys, alternated going to school with working on the farm. Before he was nine years old he evinced unusual mechanical ingenuity, making many curious toys, windmills, water-wheels, and the like, which rendered him a favorite with his playmates. He also began soon to show a great interest in astronomy and the kindred sciences, which was first awakened by an intense curiosity to know how a common almanac was made. Books of all kinds in that town were then rare, and of scientific books there were almost none; but he managed somehow to get hold of a few—one on natural philosophy, one on surveying (Gibson's), and one on navigation (Bowditch's)—to borrow the last of which he walked five miles. From one of these he learned the nature of lenses, and soon extempo-

rized for himself a rude telescope by means of his mother's spectacles, a small burning-lens, and a yard-stick. In later life he said, "I can never forget the delight with which I turned this upon the Pleiades, and for the first time saw this cluster expand into a large number of brighter stars." From Gibson and Bowditch he learned, without a teacher, the rudiments of geometry and trigonometry, and in due time obtained a good knowledge of surveying and navigation.

When he was thirteen a copy of Ferguson's "Astronomy" fell into his hands, and was devoured by him as eagerly as most boys read "Robinson Crusoe." He also had access to the articles "Astronomy," "Optics," and some others, in the "Edinburgh Encyclopædia." From thirteen until he was sixteen, except the twelve weeks of Latin mentioned farther on, he spent most of his spare time either studying, entirely without assistance, or in a little tool-shop of his father's, constructing astronomical and other instruments which he had never seen except in the diagrams of his few much-prized books. Among these instruments, which were mainly of wood, were a quadrant, sextant, terrestrial and celestial globes, orrery, eclipsareon, solar microscope, and many others. He also constructed a reflecting Herschelian telescope four feet long, which enabled him to show Jupiter's satellites and belts, Saturn's rings, the moon, and other celestial objects, to the country-folk who came from miles around to look through it. He computed all the eclipses for fifteen years to come, and made almanacs for 1830 and 1831. In order to give the places of the planets in these almanacs (never having seen a nautical almanac or astronomical tables of the planets), he made rough tables for himself, computing them from the elements of the planet's orbits as given in his book on natural philosophy. When about fourteen he with five other boys was made the subject of an experiment in teaching Latin, which impressed him with a life-long conviction that, in the ordinary methods of teaching the classics, one half the time at least is unnecessarily wasted.

The Rev. V. R. Osborn had recently started in Manchester a school in which he aimed to apply what was then widely known as the Hamiltonian system of instruction to the classics—a system, in the main, advocated by Milton and Locke, as well as by other high authorities in education, from Cardinal Wolsey and Erasmus down to Hamilton, who used it in the early part of this century. In order to settle a controversy in the Hartford papers as to the merits of the system, it was suggested that it should be applied in teaching a class of boys who knew absolutely no Latin. Accordingly, young Lyman (not then a member of the school) and a few others were invited to form the class. At the first meeting the first six lines of the "Æneid" were slowly read and translated by Mr. Hart, the teacher, with explanations, the boys one at a time repeating the translation after him, sentence by sentence, until all had gone over the lesson. It was afterward made familiar by

using an interlinear translation prepared for them by Mr. Hart. These lessons being gradually increased in length, the first three books were soon read. With their review a Latin grammar for the first time was used, which, now that the text was understood, proved a fascinating exercise instead of the usual bugbear. With this start the remaining nine books were read by means of the *clavis* of the Delphin edition of Virgil, as Mr. Hart's translation then only included three books.* The whole "Æneid" was thus completed in twelve weeks, at the end of which an examination of the class by a professor at Trinity (then Washington) College, Hartford, was pronounced highly creditable, and excited much interest at the time.

Two or three years later several of the leading men in Manchester, together with Major Bissell, an army officer, having become interested in Lyman's mechanical and scientific pursuits, and wishing him to have the advantages of a thorough education, sent an application to the Secretary of War for a cadetship at West Point. There was every prospect that the appointment would be given him, but, before the requisite time had elapsed, he, having become interested in religious matters, determined, instead of entering the military profession, to go to college with a view of becoming a minister. He had now reached the age of eighteen, had taught school two winters in his native town, and been active in a society which he had started for debate and literary practice, giving occasional lectures on scientific and other subjects. He had, withal, fallen into the habit of occasionally writing verses, which now and then got into the newspapers. This habit, begun at the age of ten or twelve, followed him to college and on occasions through life. Entering, in June, 1832, the Ellington School, then one of the most prominent preparatory schools in New England, he fitted for college in twelve months' time, entering Yale in 1833, without conditions.

During his college course he took several literary prizes; and in his junior year he was one of the originators and editors of the "Yale Literary Magazine," being associated with W. T. Bacon, W. M. Evarts, and others. In addition to his regular studies, in which he took high rank, he continued through his course his scientific pursuits, being assistant to the Professor of Natural Philosophy and having access to the observatory, from which he saw, among other objects, the famous Halley's comet at its return in 1835.

On graduating in 1837 he declined several eligible positions, among them a professorship in a Western university, a place in the Wilkes Exploring Expedition, an examinership in the Patent-Office, etc., and became for two years Superintendent of the Ellington School, among his immediate predecessors having been Hon. Alphonso Taft, of Cin-

* This translation was subsequently completed and published in Baltimore, with the names of V. R. Osborn and Levi Hart on the title-page, and serves to this day as a pony for students in Virgil.

cinnati, and Professor John L. Taylor, of Andover. After studying theology in Union and Yale Seminaries, and holding a short pastorate over the First Church in New Britain, Connecticut, he was obliged to travel for his health.

After a seven and a half months' voyage in a sailing-vessel he reached the Sandwich Islands *via* Cape Horn in May, 1846, where he remained a little more than a year. While there, he visited and mapped the volcanic crater of Kilauea, which he afterward described fully in the "American Journal of Science."

While staying at Hilo, in the family of Mr. Coan, the missionary, the unusually large rainfall on that side of Hawaii (over ten feet annually) led Mr. Lyman to construct an ingenious self-registering rain-gauge, which, by means of clock-work, drew a line on a ruled diagram, showing the time of day and all the circumstances of the rainfall.*

During his stay at Honolulu, Mr. Lyman was called upon to teach the Royal School for a few months, having among his pupils four young chiefs, who later successively occupied the Hawaiian throne, and also the chiefess who was afterward Queen Emma.

Just before leaving the islands for California, Mr. Lyman bought an outfit of surveying instruments from his friend Chief-Justice Lee. With these instruments he arrived, in July, 1847, at San Francisco, just then newly laid out among scrub-oaks and sand-hills, and adopting that name instead of its previous one of Yerba Buena. He found it a small settlement, and the only one of its streets on which there were enough buildings of any sort to show which way it ran was Montgomery Street, which then was at the water-front, and in one place was covered with water at high tide, but now is many blocks inland.

Having been commissioned as surveyor by Colonel Mason, the military governor, Mr. Lyman soon found himself fully occupied in the survey of ranches and towns in various parts of California, especially in the country between San Francisco and San José. Among these was a resurvey of the city and adjacent lands of San José (which had been fraudulently laid out by his predecessor, so that many of the lots existed only on his chart), and also the original survey of the famous New Almaden mine, probably the richest quicksilver-mine in the world.

In May, 1847, while he was engaged in surveying the town of San José, there came reports, at first uncredited, that gold had been discovered at Sutter's Mill, on the American River, a hundred and fifty miles or so up in the mountains. At length, a man who had come from the diggings showed some gold specimens in a store at San José, and, the report being at last believed, men began soon to flock to the

* One peculiarity of this rain-gauge was the device by which, in extra heavy rainfalls, which would more than have filled the reservoir, a valve, by which it was emptied, automatically opened and closed, bringing the recording pencil back to zero.

mines. When Mr. Lyman's assistants, who were earning twenty-five dollars a month, heard that their friends at the mines were making as much each day, they also were for starting immediately. Mr. Lyman induced them to finish the work in hand by the promise of going with them if they waited, which was indeed his only alternative, as no more assistants were to be had.

Accordingly, in June, he with a small party started for the mountains, in reaching which they had many difficulties to encounter. Having learned that in order to cross the Strait of Carquinez, which lay in the regular route thither, they must wait three weeks at the ferry, to take their turn with the crowds of gold-seekers already before them, they decided to take a bee-line across the flooded San Joaquin Valley. This they accomplished by improvising a unique boat out of a wagon-body, set into an envelope of rawhides, which they had obtained from wild cattle shot on the way and sewed together for the purpose.

After many other rough experiences of this kind, they reached Sutter's Mill in about a fortnight.

Though they found the district already overrun with diggers, they succeeded in extracting for themselves amounts of gold varying from fifteen to a hundred dollars each daily. The extraordinary price of provisions and all useful articles naturally used up much of their profits—potatoes, sugar, coffee, etc., costing a dollar a pound (and later three dollars!); butter, a dollar and a half a pound; shovels, ten dollars a piece; milk-pans, five to ten dollars; shirts, as high as twenty-five dollars each, etc.

From the mines Mr. Lyman sent to the East some of the first authentic accounts of the gold discovery, which produced much excitement, and found their way into many newspapers. One account was published in "The American Journal of Science."

But life in the gold-region being exceedingly rough, Mr. Lyman after about two months left them, and resumed his work of surveying, which he continued until, with entirely restored health, he returned to New Haven *via* Panama, in 1850.

Being married in that city, in June of the same year, to Miss Delia W. Wood, a daughter of the Hon. Joseph Wood and granddaughter of Chief-Justice Oliver Ellsworth, he settled permanently in New Haven, engaging in scientific and literary pursuits, among which was the preparation of the definitions of scientific words for new editions of Webster's Dictionary. In 1859 he became Professor of Industrial Mechanics and Physics in Yale College, taking an active part in organizing the Sheffield Scientific School, in which he also taught astronomy, and in the early years of the school rhetoric and moral science. In 1871, with the growth of the school, he was relieved of mechanics, and his professorship was changed to that of Astronomy and Physics. On account of impaired health, he resigned the chair of

Physics in 1884, but still retains the Sheffield professorship of Astronomy, of which science he has been the instructor from the organization of the school in 1860.

He spent the summer of 1869 in Europe, for the purpose of collecting mechanical and physical apparatus for the school, and of visiting scientific institutions. He has been a contributor to "The American Journal of Science," "The New-Englander," and other periodicals, and is the originator of various useful inventions, among which are the wave apparatus known by his name, patented and manufactured by Messrs. Ritchie & Sons, of Boston, and a pendulum apparatus for describing Lissajou's acoustic curves, constructed several years in advance of a similar apparatus made in London by Tisley & Spiller.

Professor Lyman is the original inventor of the combined transit instrument and zenith telescope for determining latitude by Talcott's method. This instrument was designed and mainly constructed in 1852–'53, and numerous observations together with a description of the instrument were published in "The American Journal of Science" and elsewhere, some ten years before the construction and published account of a like instrument by Davidson.* His aptitude in practical mechanics was of much service to him in devising and constructing apparatus for the lecture-room.

Professor Lyman has been actively interested from the first in the establishment of the Yale Observatory, and is one of its board of managers. His attention has been much given also to practical horology, and some improvements of his in escapements and compensation pendulums have proved practically valuable. He was the first to observe Venus as a delicate ring of light when very near the sun in inferior conjunction, as in December, 1866, and also before and after the transit of Venus in 1874.

He is a member of various scientific and literary bodies, among them the British Association for the Advancement of Science, and was for twenty years President of the Connecticut Academy of Arts and Sciences.

Mr. Lyman's life-work has been mainly teaching. He has the quality so necessary in a successful instructor—that of explaining difficulties with great clearness and patience. His uniform practice of treating his students as gentlemen rather than school-boys, and trusting to their sense of honor, has gained for him their universal respect and affection.

* This instrument has been in use for many years, and known by Lyman's name, in the governmental survey of India.

CORRESPONDENCE.

DISSECTION OF A GLASS-SNAKE.

[SOME weeks ago Messrs. O. R. Glover and Charles H. Lawrence, of Chicago, favored us with a living specimen of joint- or glass-snake, which had been captured on a farm owned by them in Starke County, Indiana. With a view of obtaining, if possible, any facts in addition to what was published in the Correspondence department of the "Monthly" for February and April, and in the Popular Miscellany department for the latter month, the creature was sent for examination to Dr. W. A. Conklin, Director of the Central Park Menagerie, New York, who has kindly furnished the following report.—ED.]

Editor Popular Science Monthly:

SIR: I delayed sending you any report on the chain-snake (*ophibolus*) for the following reason: Shortly after reaching the menagerie the snake laid a number of eggs, and, as I had some curiosity to see if they would be hatched, I decided not to disturb it for a few days. It remained six days coiled around the eggs, leaving them for a short time each morning to drink water. On the seventh day it was found dead. The theory that a full-fledged vertebrate animal such as this should possess power of unjointing and rejointing itself seems hardly worthy of discussion. I sent the specimen to Dr. W. S. Gottheil for dissection, and he writes me as follows: "There is a vertebral column, running the entire length of the animal, the individual segments of which are accurately fitted together, bound to each other by a complicated and firm system of ligaments, and containing continuous nerve-structures; here are muscles running from bone to bone, long internal organs, intestinal canal, liver, etc., and covering the whole is a perfectly continuous and very tough dermal envelope. There is no more possibility for it to unjoint than for a person to unjoint his head from his trunk. One peculiarity only is noticeable: the cloaca is very high up at the junction of the anterior and middle thirds of the animal's length, and the tail-piece is thus relatively very long."

I believe that in some of these animals the terminal segments of the body are neither so firmly attached nor so highly vitalized as the rest, and can be detached by a comparatively slight amount of violence, and without entailing any disability upon the animal. The tail being exceptionally long here, it may be that a comparatively large section of the body may become detached by a blow. The animal could not break into several pieces, and it certainly could not unite if it could do so.

W. A. CONKLIN,
Director of Central Park Menagerie.

FICTIONAL ASTRONOMY.

Editor Popular Science Monthly:

SIR: I note the letter of Anne M. Johnson, in the September number, on the astronomical mistake in "King Solomon's Mines." She is quite right in saying that others, besides Mr. Haggard, may make errors in regard to the moon. Here is an instance from so careful a writer as Andrew Lang: In his "Letters to Dead Authors," he tells Theocritus, "Thou wouldst see the dawn awake in rose and saffron across the waters, an Etna, gray and pale against the sky, and the setting crescent would dip strangely in the glow on her way to the sea." This is the reverse of the mistake made by Mr. Haggard and Anna Bowman Dodd. Edward King, in his recently-published poem, "A Venetian Lover," also says (line sixteen), "The young moon pales before approaching dawn." Many other similar instances might be quoted, some from rather unexpected sources.

But Mr. Haggard excels all competitors in that his error of making the crescent moon rise soon after sunset is only one of a series. By referring to the book, it will be seen that the very next night "the full moon rose in splendor about ten," without any explanation of the change from "crescent" to "full" in some twenty-four hours, or of a full moon rising so late in a country which seems somewhere near the tropic of Capricorn. Following the narrative a little further, we find that, on the succeeding day, there is an eclipse of the sun, with total darkness for nearly half an hour. As it is hardly necessary to mention, an eclipse of the sun can take place only at new moon, and the total obscuration never lasts more than a very few minutes—four, if I remember rightly. It will be seen that Mr. Haggard has made the most of his opportunities for blundering. EDWARD H. BEEDE.

CHICAGO, *August* 31, 1887.

ANOTHER ANOMALY IN PLANT-GROWTH.

Editor Popular Science Monthly:

SIR: To the illustrated letter of E. W. B. Canning, in your September number, entitled "An Anomaly in Plant-Growth," I

would add this description of a case observed at "Harmon's Bottom," in Bedford County, Pennsylvania, twenty years ago. Two sugar-maples had been united by the natural grafting of the branch of one of them upon the trunk of the other, about six feet away, and at ten feet above the ground. The tree-trunks were both intact, with their roots, but the trunk of the second tree was strikingly smaller below the graft than above it, and one might consider this due to retardation of the circulation below, as well as increased flow of sap above. In your correspondent's illustration, the trunk below, being severed from its roots, became an appendage to the rest of the circulating system. It has been speculated that there is circulation downward in plants, the roots discharging to as well as eliminating from the soil, and that this action unfits a soil as much for repetition of crops as does exhaustion of nourishing constituents. The preference for change in kinds of trees that spring up after forest-clearing—a natural rotation of crops—has been very generally remarked. F. Z. SCHELLENBERG.

IRWIN, PENNSYLVANIA, *September* 8, 1887.

WHAT IS A BAYOU?

Editor Popular Science Monthly:

SIR: A friendly, well-meaning, and timely correction is never amiss. When the error to be rectified is such as is likely to arouse feelings of regretful remonstrance in a community, the correction is the more pardonable; when it is likely to color the opinion of a nation, the correction becomes imperative.

The correction which the writer, one of a "community" supposed above, would most humbly beg leave to make, is to an error that the writer of a most able and interesting article in the July issue of "The Popular Science Monthly," entitled "The North American Lakes," has doubtless unwittingly been guilty of. I do not presume to say that he was led to the commission of the error by any ignorance of his subject, but rather by a want of a sufficient knowledge of the local nomenclature of Louisiana.

To quote the author's words—"Lake Borgne and Lake Pontchartrain have been captured from the Gulf by the delta of the Mississippi, while numerous small lakes, called bayous," etc. We will say nothing of the derivation of the word, which, of itself, can not be construed to mean a lake, for, alas! local usages frequently defy all attempts at classification, and are by no means fair criteria for the true meaning and application of a term; but, as a Louisianian, we will say that the term "bayou," in the article cited, has been used under some misapprehension.

If the author will procure for himself an authentic map of Louisiana, he will find the lower part of the State to be covered with almost a network of small water-courses, although they scarcely deserve the name, varying in size from the smallest "creek" to channels just navigable by small vessels, all exceedingly sinuous and very river-like. These are what, in Louisiana, are called "bayous." Whatever may be the geological origin and nature of these bodies, the fact still remains that the term "bayou," in Louisiana, is applied to nothing at all resembling a "lake." Respectfully yours,

C. M. WILLIAMS.

CARROLLTON, LOUISIANA, *September* 5, 1887.

EDITOR'S TABLE.

SCIENCE IN HARNESS.

NO journal has upheld more steadily than "The Popular Science Monthly" the principle that, as fast as they are established, the truths of science shall be applied to useful purposes, and, through popular education, be made as widely available as possible for the general guidance of life. And yet we can not look with favor upon what many persons doubtless regard as a very signal and happy example of the utilization of scientific conclusions—we mean the authoritative and dogmatic teaching as to the effects of alcohol, now provided for by the school laws of many States. It is only right, therefore, that we should assign our reasons for holding that this is not a case of the legitimate application of scientific truths to practical life.

In the first place, it is an abuse of power on the part of the majority. In the "temperance" controversy as a distinct social issue we have no wish to interfere; but we can not ignore the fact that there is such a controversy, nor can we consent to believe, with the advocates of prohibitory legislation, that their opponents are neces-

sarily persons devoid of all high motives, and hardly to be distinguished from the criminal population. But if a minority in the State is to be respected so long as it is law-abiding, its opinions are also to be respected; and to seize hold of the school-machinery of the State to inculcate opinions that are not accepted by the minority, and that tend to set the minority in a very unfavorable light, is not right or just. If every triumphant party were to seize the public schools for the inculcation of doctrines favorable to its own party interests, there would soon be an end of our public-school system. It would always be easy to invoke the name of science. If it were desired to rear a race of protectionists, it would only be necessary to claim that you were teaching the truths of political economy. The proper text-books would be prepared, and teachers, on pain of dismissal, would have to enunciate the doctrines of Henry C. Carey and Horace Greeley. And so in the days of slavery the science of ethnology might have been invoked either on the side of abolition or in defense of the slave system, according to the leaning of the majority. At this moment we have the president of a New England college recommending the majority in the several States to use their power to enforce the teaching of certain specific views of New Testament history which he is pleased to declare all competent critics have accepted.

"But," say the advocates of the teaching to which we refer, "we only wish to inculcate the real results of scientific research in regard to alcohol." To which we rejoin that, in a community like this, it is too soon to inculcate the truth, supposing you have it, if the issue is still practically open, and if large numbers of your fellow-citizens are not persuaded that what you call the truth *is* the truth. Minorities have their rights even when they are in the wrong, and to use a school system which the minority support to teach opinions which the latter do not believe to be true is unfair.

But there is another view of the matter. Are the advocates of such instruction prepared to have it communicated in a thoroughly non-partisan spirit? Are they prepared to have the whole truth taught, or do they want only that part of the truth which is favorable to the specific end they have in view? Are they prepared, for example, to give any fair representation to the views of those who consider that alcohol has its important uses, dietetic and social? A few years ago the "Contemporary Review" opened its columns to a discussion of the alcohol question; and we are safe in saying that there was a preponderance of opinion among the many eminent men who joined in the discussion, in favor of a moderate use of alcoholic beverages. In the August number of the "North American Review" a well-known physician of this city enters a plea against the indiscriminate condemnation of narcotics and stimulants. Is all this opinion to go unrepresented when the alcohol question is introduced into the schools? Of course it must, or the specific object of the teaching would be ruined. We say, therefore, that this is not teaching science; it is harnessing science to the "temperance" cart, and driving her under instructions from "temperance" headquarters.

We need not, however, confine ourselves to general speculations as to what is likely to happen when science is made subservient to the propagation of special views, for we have an example—and a striking one—of what *does* happen in such a case. In a recent number of the "Boston Medical and Surgical Journal," Dr. Joseph W. Warren, assistant in physiology in the Medical School of Harvard University, gives an account of a pamphlet on the subject of "Alcoholic Liquids as Therapeutic Agents," issued by the Women's Temperance Publication Association of Chicago. This pamphlet, it is true, consists of a chapter from a larger work

on the "Principles and Practice of Medicine"; but the chapter in question was selected for use as a tract because it states the case against alcohol with all the exaggeration and suppression needed for party purposes. Dr. Warren describes it as "full of error and misstatement concerning the physiological action of alcohol," while "the therapeutic inferences drawn therefrom are, to say the least, most doubtful." One example will suffice to show to what extent—if we may trust Dr. Warren, who writes with a very full command of his subject—the truth has been economized in the pamphlet in question. The author, after stating that "the experimental researches of Lallemand, Perrin, and Duroy proved conclusively that alcohol was eliminated as alcohol, unchanged chemically, from the lungs, skin, and kidneys," adds that these experiments have been confirmed, except that it is claimed that "the amount eliminated is not equal to the whole quantity taken." "Surely," says Dr. Warren, "no beginner would infer from the last quotation that *every competent investigator* had found the amount eliminated, not only *not equal to the whole quantity taken*, but really to form only a small fraction of it; yet such is actually the case." We have not space to follow Dr. Warren in his very thorough examination of this anti-alcohol manifesto; but we very heartily concur with him in some of his concluding remarks. "There are times," he says, "when it may be well not to tell the whole truth; but I have yet to learn how the human race can be benefited, in the long run, by systematic deception, and by the wholesale circulation of what is, to say the least, not true." Again: "The temperance movement of the future will have to recognize that the field for its activity lies not in the dissemination of falsehood about what alcohol is and does, but in the control of its rational use and in the prevention of all abuse. Intemperance is a terrible weed, but its roots will be found to be entangled amid many social problems of heredity, poor food, overwork, bad cooking, and bad homes, all quite as important, if not more important, than the question of alcohol." The main object of the present article, however, is to protest, in the name of science, against the tethering of it to any party policy whatever; and in the name of social and political justice against laying hold of the public schools for the propagation of opinions based as yet upon very incomplete inductions. Our temperance reformers have ample scope for a wise and beneficial activity without seeking to control the schools and without perverting opinion by the dissemination of unfounded statements under the guise of science.

A FURTHER ADVANCE.

We noticed, at the time of its appearance, an article by the celebrated Roman Catholic biologist, Mr. St. George Mivart, claiming for members of the Catholic Church the fullest liberty of opinion in all matters pertaining to science. In Mr. Mivart's opinion, it was a fortunate thing for the world that the Church had blundered so egregiously in condemning and punishing Galileo for putting forward the true theory of the heavens. It was a lesson that the Church would not be likely to forget as to the expediency of minding its own business; and it was an instance to which the laity could always appeal in case ecclesiastical authority should ever seek to set itself up as a judge of scientific questions. To-day, after a lapse of two years, Mr. Mivart comes forward with another plea for liberty—this time in connection with questions of history and criticism. He states that, in writing his former article, he purposely expressed himself very strongly, in order that, if there was anything in the position he took of a nature to call for ecclesiastical censure, he might hear of it; but that, far from having been visited with censure, he

had received "warm thanks from members of the clergy, most varied as to rank and position," and particularly from "a most esteemed superior of one of the mediæval religious orders." He therefore feels that it is time to take another forward step, and say that, in matters of historical and Biblical criticism, the only appeal must hereafter be to facts. It will not suffice to say that such and such statements are contained in Holy Writ, or have formed part of the ordinary teaching of the Church; the only pertinent questions will be: Are they true? Are they supported by such evidence as challenges the assent of impartial inquirers? He then proceeds to give a summary of the leading conclusions of such advanced Biblical critics as Reuss, Colenso, Wellhausen, and Kuenen, and states that, while he is not prepared—does not, indeed, feel himself competent—to say that the views of these eminent men are correct in every particular, he is convinced, after careful inquiry, that they are correct in the main. He considers that these men occupy, in relation to Biblical criticism, very much the same position that Copernicus occupied in relation to the astronomy of his age; and that, just as the world accepted the views of Copernicus when it became intelligent enough to understand them, so the world will eventually adopt the views of the liberal school of Biblical critics. How far these writers go may be judged (in one instance) from Mr. Mivart's statement that "the book of Chronicles is considered (by them) as a thoroughly unhistorical work, the history contained in it being habitually falsified in accordance with the point of view of the priestly code." According to Mr. Mivart, it is quite open to the members of the Catholic Church to accept these views, and, in all such questions, to yield simply to the weight of historical evidence. "It is," he says, "the men of historical science now, and not theologians or congregations, who are putting us in the way of apprehending, with some approach to accuracy, what the truth is as to the dates, authorities, and course of development of the writings which were inspired for our spiritual profit."

We presume Mr. Mivart will now wait to see whether ecclesiastical censure will fall upon him for this last utterance. He says he does not think it will. He has reason to believe that "broad views are not in disfavor at the Vatican, though sudden or abrupt action is neither to be expected nor desired." It seems, then, to be a question as to whether that section of the Christian Church which has hitherto been accounted most conservative of traditional opinions, and most resolutely hostile to all the new views of science, is not in reality destined to prove itself the most hospitable and friendly to such new views. The situation is a singular one, and merits the attentive consideration of some excellent people who consider their theology a great advance in point of liberality and rationality upon that of Rome, and who yet have an evil eye for such scientific doctrines as that of evolution, to say nothing of a free critical handling of the sacred texts. On the subject of Biblical criticism we have no opinions to offer; but we must say that we feel like agreeing with Mr. Mivart that, in this field, as in every other, the authorities to be deferred to are those who have a competent knowledge of facts, not those who are merely the official conservators of ancient dogmas.

LITERARY NOTICES.

APPLETONS' PHYSICAL GEOGRAPHY. By JOHN D. QUACKENBOS and others. New York: D. Appleton & Co. Pp. 140. Price, $1.60.

THIS work has been prepared on a new plan. Physical geography, comprising parts of a number of sciences, covers a wider field than one man can be thoroughly familiar with; hence, in order to secure the advantage of special knowledge over the whole field, this work has been written by several

hands. The section on the general structure and geological history of the earth has been prepared by Dr. John S. Newberry, Professor of Geology and Paleontology in Columbia College; that devoted to the geological history of the North American Continent, by Professor Charles H. Hitchcock, of Dartmouth College; the portion relating to general physiology and the physical features of the United States, by Mr. Henry Gannett, Chief Geographer of the United States Geological Survey; the pages explaining terrestrial magnetism, with the chapters on volcanoes and earthquakes, coral islands, the earth's waters, and meteorology, by Dr. W. Le Conte Stevens, Professor of Physics in the Packer Collegiate Institute. Dr. N. L. Britton, Lecturer in Botany, Columbia College, furnished the chapter on plant-life; Dr. C. Hart Merriam, the Ornithologist of the Department of Agriculture, those relating to zoölogy and the animal life of the United States; Professor William H. Dall, of the Smithsonian Institution, that on ethnology; and Mr. George F. Kunz, gem expert and mineralogist with Messrs. Tiffany & Co., of New York, that on precious stones. Throughout the book references to standard works have been inserted, which will guide pupils and teachers to fuller sources of information on the various topics which can be only touched upon in a school text-book. The text is copiously illustrated with pictures, diagrams, and maps in color, on which no pains have been spared to secure accuracy and mechanical excellence.

THE PRINTING OF COTTON FABRICS, COMPRISING CALICO BLEACHING, PRINTING, AND DYEING. By ANTONIO SANSONE. Manchester, England: Abel Heywood & Sons. Pp. 375, with Nineteeen Plates, Thirteen Text Illustrations, and Eight Plates of Printed Samples.

THE applications of new chemical discoveries to technical purposes have become so frequent during the last quarter of a century as to cause almost a complete change in several important branches of modern industry, developing new fields of human application and effecting marked improvements in manufacturing generally. Like other industries, the colorist branch, which may be said to be the pet child of modern chemical investigation, has not been slow to feel the effect of the introduction of scientific methods in the every-day work of the factory; the result has been a steady progress and improvement in the methods of obtaining colors on fabrics, consequent on the introduction of new coloring-matters and a better understanding of the properties of the substances used, and of the principles which govern the formation and fixation of each color on the fiber.

The printing of tissues—that is, the art of fixing various colors which form more or less elaborate designs on cloth—is a very complicated process, requiring for its successful completion the assistance of all the skill which chemical and mechanical progress has placed at the service of manufacturers. This progress, however, which permits of greater facilities being introduced gradually, rendering possible the adoption of novel and more complicated designs which could not be easily employed with older methods, makes it at the same time imperative on those engaged in this branch of industry to keep themselves posted on all the forward steps made by others, in order to meet the artistic requirements of the consumer, and the competition of rival manufacturers.

This progress is so steady and gradual that it has to be followed incessantly. Publications treating specially of this branch of manufactures are not very plentiful; the continual changes and improvements are liable to deprive a book of its practical usefulness a few years after its publication. A complete work on the subject, embodying the latest devices and processes in use, can, therefore, not help being welcome both to the trained colorist and to the student. The author is well fitted for the task he has undertaken, having been for several years director of the School of Dyeing and Printing at the Technical School of Manchester, the center of the printing industry.

Theory and practice are given an equal share of attention, which they both deserve in an art in which scientific training, skill, experience, and artistic taste have all to contribute to the result. The opening chapter is devoted to the history of calico-printing which is traced from its origin in India, to its present flourishing expansion.

Before the tissue can actually be printed upon, it is necessary that it should be bleached; to this important preliminary op-

eration an interesting chapter is devoted. The colors and materials used by the calico-printers are many, and are divided into three classes—colors, mordants, and thickening materials. The colors are divided as follows: mineral colors, the importance of which has largely decreased of late in calico-printing; natural organic coloring-matters, such as logwood, madder, indigo cochineal, berries, etc., which are used chiefly under the form of extracts; artificial coloring-matter, or coal-tar colors. The origin, properties, chemical composition, etc., of each coloring-matter are given. The mordants include all those substances possessing the property of causing coloring-matter to become fixed on the fiber, either by precipitation, adhesion, or otherwise. Salts of alumina, iron, chrome, tin, lead, zinc, antimony, etc., possess mordant properties, and occupy an important place in the preparation of the print-colors. Tannin, soaps, oils, etc., are also extensively used.

Thickening materials are indispensable to the calico-printer. In order to prevent the colors on the cloth "running" into each other, and to obtain a distinct separation between the different shades, all the printing-colors have to be thickened. This is done by means of starch, gum, albumen, etc. The colorist has to be thoroughly familiar with the properties of all the substances he uses, and with their action toward each other. Considering that some of the print-colors have to be composed by mixing together from six to ten different materials, the knowledge of the properties of each is important. A short chapter is devoted to water. The most important part is that devoted to the printing processes, the practical work of the colorist. It includes chapters on preparing thickenings; preparing mordants; steam-colors (steam pigment-colors; steam aniline-colors, steam alizarin-colors, dyewood, redwood, catechu, and compound steam-shades); steam mineral colors; a chapter on steam-colors of the most recent introduction, and on new solvents; oxidation-colors, colors obtained by reduction; dyed colors, the designs on which are obtained by resisting and discharging processes.

The machinery and apparatus employed in calico-printing are described in another chapter, and illustrated. The illustrations are many, and represent the most important apparatus which are in use in print-works. The most complicated of these is the twelve color printing-machine, by means of which the most complicated and elaborate designs can be produced on cloth.

Short chapters are devoted to the finishing of printed goods; electricity in printing; and printing woolen fabrics.

A table, showing the principal styles of calico-printing, and the number of shades that can be produced in each style, is also given. Besides the numerous illustrations the volume contains eight plates of printed samples of calico, chosen so as to show the different styles.

Taken altogether, the volume under review contains a very large amount of practical information. The student will find in it a complete guide in his first attempts at laboratory work in the branch he chooses to follow, while the expert colorist can rely upon it as a valuable reference-book.

ROMANTIC LOVE AND PERSONAL BEAUTY: Their Development, Causal Relations, Historic and National Peculiarities. By HENRY T. FINCK. London and New York: Macmillan & Co. Pp. 560. Price, $2.

MANY sober-minded persons would expect a book on romantic love and personal beauty to contain nothing better than silly sentimentalism, if happily it contained nothing worse. But these two closely connected subjects have other aspects than the sentimental one. Romantic love, by which is meant, in this book, the complex emotion that leads a civilized person, free from considerations of policy, to desire marriage with a particular individual, has a powerful influence in directing the development of the race. For the feelings that determine the choice of partners in marriage determine also what physical, mental, and moral characteristics shall be brought together and transmitted to the next generation. The design of Mr. Finck's book is to analyze romantic love and personal beauty, and to trace their development and history. In what he calls a "chemical" analysis he compares love to a musical note, composed of the sexual relation as its fundamental tone, with eleven overtones, viz.: individual preference, monopoly or exclusiveness, jeal-

ousy, coyness, gallantry, self-sacrifice, sympathy, pride of conquest and possession, emotional hyperbole, mixed moods—major and minor—and admiration of personal beauty. Love thus constituted, he maintains, is unknown to savages, and was not experienced even by the civilized peoples of antiquity. In fact, he affirms that animals approach nearer to the emotion of romantic love than savages, for many animals, especially birds, have a period of courtship in which they display at least four of the "overtones" of romantic love, viz., jealousy, coyness, individual preference, and admiration of personal beauty, while savage men obtain their wives by capture or by paying a price for them in goods or labor, without any preliminary love-making. Even among ancient civilized nations he maintains that romantic love could not exist, because women then held a degraded position, and were carefully secluded both as maids and matrons, marriages being arranged for by the parents of the young people, thus allowing no opportunities for courtship and for free matrimonial choice. Among his evidence for this thesis is the statement that there is no mention of romantic love in the Bible, not excepting the Canticles. He disposes of Herder, who has asserted the opposite, by calling him "a very unsafe and shallow guide in this matter," and says, "So far as love is referred to in the Song of Solomon, it is probable that conjugal affection is meant." He makes a sharp distinction between conjugal and pre-matrimonial love, in which many persons will not agree with him, and claims that the former is developed earlier in the history of all peoples than the latter. Mr. Finck sees no evidence of a knowledge of romantic love in the verses of Anacreon or Sappho, of Catullus or Ovid, nor in the deification of Eros and Cupid. He does credit Ovid with depicting an approach to romantic love, but this approximation was soon lost to the world, and the sentiment remained unknown throughout the dark ages, even including the period of chivalry, which much-lauded institution Mr. Finck deems to have been less refined in practice than in theory. According to our author, romantic love began its existence A. D. 1274, in the breast of Dante, when he was a nine-year-old boy, and its advent is described in the "Vita Nuova." But Mr. Finck says that Dante "hyper-idealized his passion," and that it was Shakespeare who first mingled the sensuous, æsthetic, and intellectual elements in proper proportion; next to Shakespeare's poetry, he deems Heine's the most valuable depository of modern love. In giving a further detailed account of the genuine romantic sentiment, he touches on the topics, old maids, bachelors, genius in love, kissing—past, present, and future—how to win and how to cure love, and the characteristics of French, Italian, Spanish, German, English, and American love.

In treating of personal beauty he very properly insists on hygienic living, which involves shunning many so-called beautifiers, as the basis of physical beauty, and credits some beautifying influence to crossing, romantic love, and mental refinement. After a short discussion of the evolution of taste, he describes the different ideals of beauty, savage and civilized, for the various parts of the human form, from the feet to the hair, with hints for improving the appearance of each part, and concludes with an examination of national types of beauty.

Mr. Finck supports his various statements with a multitude of analogies, allusions, and quotations. He maintains throughout a playful attitude toward his subject, which leads him into the use of slang and colloquial language in order to make fun; for instance, such expressions as "get left," "high-toned," "sparking," and "stabbed by a white wench's black eye." He is also careless about his syntax, thus he says, "A favorite Slavonic device is to cut the finger, let a few drops of her blood run into a glass of beer," etc., the pronoun having no antecedent. He defines a morganatic marriage as "a special royal euphemy for bigamy," but such a marriage need not involve bigamy. His science is as careless as his language; thus he speaks of existing savages as representing "a later stage of evolution" than existing animals. In short, this book is the production of a clever writer; it is clean and entertaining reading, but it is no addition to our knowledge of a subject which is really worthy of earnest study.

FACTS AND FICTIONS OF MENTAL HEALING. By CHARLES M. BARROWS. Boston: H. H. Carter & Karrick Pp. 248. Price, $1.25.

IT is a friendly hand which has written these chapters. According to Mr. Barrows's preface, he "is convinced, by the results of many careful tests, that if the mental treatment of disease be not all that its most sanguine advocates picture it, it is a powerful therapeutic agent when skillfully used, and based on a philosophy which has done the world incalculable good." In the opening chapters the author gives as clear an account as could be expected of the somewhat confused and contradictory ideal philosophy and pantheistic creeds of the mental healers, little if any of which appears to be essential to mental healing; "indeed, a majority of the cures of this character," says Mr. Barrows, "have been wrought by persons utterly ignorant of, or disbelievers in, the doctrines of modern psychopathy." He describes a number of cures without medicine effected by regular physicians either by acting on the mind of the patient, or by resigning him to the recuperative power of a strong constitution. None of the cases of relapse or death under mental treatment which have been reported are alluded to by Mr. Barrows, although he mentions that one of the great lights of "Christian science" was recently prostrated with nervous exhaustion, and obliged to seek medical aid; and that another, who had become so enthusiastic as to declare that he could never be sick, died within a year of hæmorrhage of the lungs. The concluding chapters consist of more or less relevant matter drawn from Buddhism, Brahmanism, and the philosophy of Emerson.

PALÆOLITHIC MAN IN NORTHWEST MIDDLESEX. By JOHN ALLEN BROWN. Illustrated. London: Macmillan & Co. Pp. 227.

THIS contribution to the study of prehistoric man in Britain embodies the substance of papers read before various scientific societies, describing investigations by the author in the northwestern portion of the county which environs London north of the Thames. The river-deposits here run back for about three miles, rising in terraces to more than one hundred and forty feet above the present level of the stream. The author describes and figures a large number of worked flints from the gravels of various levels, as well as similar implements from other sources. He reviews the customs of savage tribes in various parts of the world, who still use stone implements, and from this material constructs a picture of Paleolithic life in Middlesex. As to the antiquity of man in Britain, he concludes that the river-drift hunter of the Thames Valley, entering the British Isles at least as early as the first Continental period, saw the last submergence of the greater part of the British Isles beneath the sea, survived the Glacial period which followed the re-emergence of the land, and, as the glaciers retreated, reoccupied that portion of the country from which the sea and the ice had driven him.

GILMAN'S HISTORICAL READERS. Nos. 1, 2, and 3. By ARTHUR GILMAN. Chicago: The Interstate Publishing Company.

THE making of books for young persons is not always an easy matter, and this is conspicuously the case with historical books. Most of the short and concise histories intended for school use are so condensed in matter, so filled with details and with useless names and dates, that they but poorly fulfill the purpose for which they are written. The true end to be aimed at in teaching history to the young is to give them a clear and correct outline view of the history of the leading nations, and impress this view as vividly as possible upon their minds. But too often the books they have to study are so overloaded with detail that the outlines of the whole are lost in the multiplicity of the parts; and thus the attention and the memory are heavily taxed without any corresponding benefit.

The books now before us are not liable to this objection. Mr. Gilman seems to have in the main an excellent idea of what matter and how much should be introduced into a school-book on history. Very few of his chapters are crowded with detail, and for such cases of the kind as do occur there is generally some special reason. The three volumes on American history form a graded series, the first being the simplest and the last the most difficult. The first volume is devoted to the discovery of the

continent, and the early voyages before the settlement of North America. The second covers the period of colonization down to the extinction of the French power east of the Mississippi. The third and concluding volume is devoted to the "Making of the American Nation," by which term the author means "the process by which the loosely-connected American communities outgrew their colonial condition of social and political life, and developed into a nation." This process, Mr. Gilman holds, was not completed till after the civil war and the reconstruction of the Union, since it was not until then that the people became one in sentiment in all parts of the land. Throughout his work the author has avoided, for the most part, the details of battles and of political intrigues, which fill so large a space in many historical works, rightly deeming them inferior in importance to those more quiet but deeper movements of society which really determine military and partisan affairs themselves. The book may be heartily recommended to the young, and to all instructors engaged in the teaching of history.

GRASSES OF NORTH AMERICA: FOR FARMERS AND STUDENTS. By W. J. BEAL, Michigan Agricultural College. Published by the author. Pp. 457. Price, $2.50.

THE author's aim has been, as is implied in the title, to furnish such an account of the grasses which more commonly come under observation as will be interesting and useful to the farmer and student, as well as to the general reader who has never studied botany. While no attempt has been made to write a complete account of the structure and physiology of grasses, such information is given on these points as will probably be sufficient and satisfactory to the classes of persons mentioned. The first chapter is, in fact, devoted to "The Structure, Form, and Development of the Grasses," and gives intelligible descriptions of their parts and the philosophy of their growth. In the chapters that follow are considered: "The Power of Motion in Plants"; "Plant-Growth" (germination, the functions of green leaves, the plant as a factory, and the composition of plants, particularly of American grasses); "Classifying, Naming, Describing, Collecting, and Studying"; "Native Grazing-Lands"; "Grasses for Cultivation" (under which head thirty-one species are described and figured); "Early Attempts to Cultivate Grasses"; "Testing Seeds, some Common Weeds"; "Grasses for Pastures and Meadows"; "Preparation of the Soil and Seeding"; "Care of Grass-Lands"; "Making Hay"; the improvement of grasses; and "Grasses for the Lawn, the Garden, and for Decoration." Although clover is not a grass, farmers regard it as economically in that category, and a chapter is therefore given to it and other leguminous forage-plants. The treatise is concluded with chapters on "The Enemies of Grasses and Clovers" and "The Fungi of Forage Plants," both of which are well illustrated, a bibliography, and a convenient index. A second volume is in preparation, to contain the descriptions of all the known grasses of North America, with illustrations of one species, and sometimes more than one, in each genus, notes on cultivation, and a chapter on geographical distribution.

CIRCULARS OF THE BUREAU OF EDUCATION. No. 1. 1887. Washington: Government Printing-Office. Pp. 89.

THE present number of the "Circulars" is an account of the College of William and Mary, prepared by Professor Herbert B. Adams as a contribution to "The History of Higher Education." The history of this institution, of which Washington was a chancellor, and Jefferson, Chief-Justice Marshall, and other distinguished statesmen were graduates, is made to suggest several lessons bearing upon the higher education, of which the author emphasizes the ideas of "a college-capital, or at least of higher education, in a municipal rather than in a rural, or even suburban, environment; and the revival of that close connection between education and good citizenship which made the College of William and Mary a seminary of statesmen"—ideas which are considered more specifically with reference to what the author declares to be the greatest educational need of our time—the application of historical and political science to American politics.

A MANUAL OF WEIGHTS AND MEASURES. By OSCAR OLDBERG. Chicago: Charles J. Johnson. Pp. 246. Price, $1.50.

THIS book is designed for a text-book and a book of reference, and gives information of practical as well as theoretical value on the important subject, with a fullness and method that we have not observed in any other single work. It contains the elements of metrology; the relations between metrological systems and arithmetical notation; a brief review of the development of weights and measures; the demands of practical medicine and pharmacy in the matter of subdivision of the units employed; the metric system; American and English weights and measures; the relations of weight to volume; specific weight; specific volume; the construction, use, and preservation of balances or scales, weights and measures, and of alcoholometers, urinometers, and other hydrometers; and extensive tables of equivalents. Careful attention has been given to the applications of weights and measures to prescribing and dispensing, and to the construction of formulas for liquid preparations.

THE STRUGGLE FOR RELIGIOUS AND POLITICAL LIBERTY. By THEO. C. SPENCER. New York: The Truth-Seeker Company. Pp. 140. Price, 75 cents.

THE progress of political liberty occupies but a small portion of this book, which is mainly devoted to pointing out the defects, inconsistencies, and cruelties of the religions of the Western world. The claims of the Bible to be an inspired book are disputed, and it is compared to the Koran and the Book of Mormon. A sketch is given of the chief persecutions of Protestants and Catholics, and of the collisions between various Protestant sects. The Church of Rome is declared to be the chief obstacle to religious liberty.

NERVOUS DISEASES AND THEIR DIAGNOSIS. By H. C. WOOD, M. D., L.L. D. Philadelphia: J. B. Lippincott Company. Pp. 501. Price, $4.

THIS work is described by the author as a treatise on the phenomena produced by diseases of the nervous system, with especial reference to the recognition of their causes. Dr. Wood classifies nervous disorders under the following heads: Paralysis, Motor Excitements, Reflexes, Disturbances of Equilibration, Trophic Lesions, Sensory Paralysis, Exaltations of Sensibility, Disturbances of the Special Senses, Disorders of Memory and Consciousness, Disorders of Consciousness, and Disturbances of Intellection. The descriptions are clear, and a copious index is appended to the volume.

DERMATITIS VENENATA: An Account of the Action of External Irritants upon the Skin. By JAMES C. WHITE, M. D. Boston: Cupples & Hurd. Pp. 216. Price, $2.50.

THIS book is a manual for the medical practitioner, comprising accounts of the action of those vegetable, animal, and mineral substances which produce inflammation of the skin when externally applied, with directions for treating such inflammation. The plants are arranged alphabetically by families, and comprise a hundred species. The irritant action upon the skin of various vegetable products and chemicals is described, and also of the bites and stings of insects.

THE CURABILITY OF INSANITY AND THE INDIVIDUALIZED TREATMENT OF THE INSANE. By JOHN S. BUTLER, M. D. New York: G. P. Putnam's Sons. Pp. 59. Price, 60 cents.

THE author recommends a preventive treatment in the incipient stages of the disease; lays particular stress upon the advantage of individualization in treatment, or its adaptation to the character and circumstances of individual patients and the manner in which their affection manifests itself; and advocates the separation of curable cases from those which are hopeless.

THE GRAPHICAL STATICS OF MECHANISM. By GUSTAV HERRMANN. Translated and annotated by A. P. SMITH. New York: D. Van Nostrand. Pp. 158, with Plates.

THIS work is intended to be a guide for the use of machinists, architects, and engineers, and a text-book for technical schools. The graphical method is becoming extensively disseminated in engineering circles, as its advantages over the analytical method are more and more recognized, and its further development is kept constantly in view. Its application has been impeded by the difficulty of taking account of friction

and the special hurtful resistances to motion, the calculations of which have hitherto been confined to the analytical method. No method being known to the author by which the frictional resistances and efficiency of any desired mechanism can be graphically determined, he has endeavored, in his lectures before the polytechnic schools of Aix-la-Chapelle, to show the relations existing between the forces in mechanism in a simpler form than that offered by the analytical method. The present treatise, which the translator characterizes as containing "almost discoveries" on the subject, has grown out of that endeavor.

COMPRESSED GUN-COTTON FOR MILITARY USE. Translated from the German of MAX VON FÖRSTER. New York: D. Van Nostrand. Pp. 164. Price, 50 cents.

HERR VON FÖRSTER'S practical manual on the application of gun-cotton, which rests largely upon the evidence of more or less extensive experiments performed in Germany, is preceded by an account of the manufacture, properties, and uses of modern gun-cotton, by Lieutenant John P. Wisser, of the United States Army.

SYNOPSIS OF THE NORTH AMERICAN SYRPHIDÆ (Bulletin of the United States National Museum, No. 31). By SAMUEL W. WILLISTON. Washington: Government Printing-Office. Pp. 335.

THE family of *Syrphidæ* is one of the most extensive in the order of *Diptera*. "They contain among them many of the brightest-colored flies, and numerous specimens are sure to appear in every general collection of insects. None are injurious in their habits to man's economy, and many of them are very beneficial." To be more definite in popular description—"they are flower-flies, and feed upon honey and pollen. They are observed on blossoms of sweet-smelling, melliferous plants, such as the *Hymenoptera* prefer; and patches in bloom of blackberry (*Rubus*), wild-cherry (*Prunus*), dogwood (*Cornus*), Canada thistle (*Cirsium*), and elderberry (*Sambucus*), will always be sure to reward the patience of the collector. Some species, as those of *Syritta*, *Spærophoria*, *Mesograpta*, etc., will be seen wherever there are blossoms. Species of the last, especially, are very abundant about cornfields when the plants are in blossom, and will frequently alight upon one's hands; these 'sweat-flies' are feared by not a few persons, under the belief that they will 'sting.' All are sunshine-loving, and will rarely be found except in the middle of bright, unclouded days." About three hundred species are described in this volume from the region north of Mexico, in such a way that the author hopes that even the non-entomological student, with a little exertion, may be able to identify them.

THE USE OF ELECTRICITY IN GYNECOLOGICAL PRACTICE. By GEORGE J. ENGELMANN, M. D., St. Louis.

DR. ENGELMANN believes that electricity is a valuable agent in treatment, which had, however, in his practice failed to give uniformly satisfactory results. He set himself to work to investigate the causes of the diversity in the efficiency of its application, and publishes his experiments and the results of them in the present paper. His decided success—in the treatment of pelvic disorders—in the past year, "no longer accidental, but the result of method"—has convinced him of the value of the remedy, which he is assured, when fully developed, will assume prominence. Its success and general adoption, he believes, depends upon precision and uniformity of measure and record; and he has given here, as a contribution to those factors, his own system, which includes the milli-ampère intensity of the current; size of electrodes for calculation of density; time of application, for calculation of quantity; resistance of the tissues in ohms when such resistance was unusual, or when an explanation of the intensity of the current seemed called for.

THE CITY GOVERNMENT OF ST. LOUIS. By MARSHALL S. SNOW. Baltimore: N. Murray. Pp. 40. Price, 25 cents.

THIS monograph is one of the Johns Hopkins "University Studies in Historical and Political Science." The "Studies" are now in their fifth series, which is especially devoted to the subjects of municipal government and economics. The history of St. Louis is given from its foundation in 1764, with the various steps of its growth as an infant settlement, a community, a munici-

pality, and a city absorbing the county, down to the operation of the present charter, which went into effect in 1877. Mr. Snow believes that a careful study of this charter "will convince any impartial man of its great worth as a framework for a system of municipal government. The length of the term of its municipal officers; the carefully-framed provisions to secure honest registration of voters and an honest vote at the polls; the guards and checks upon all who administer the financial affairs of the city; the provisions against an undue increase of the public debt; the plan by which the important offices filled by the mayor's appointment are not vacant until the beginning of the third year of his term of office, so that as rewards of political work done during a heated campaign they are too far in the dim distance to prejudice seriously the merits of an election—these are a few of its important advantages as a plan of city government. Since its adoption it has worked well, and but few amendments have been suggested."

AN INTRODUCTION TO THE STUDY OF EMBRYOLOGY. By ALFRED C. HADDON, M. A., M. R. I. A., Professor of Zoölogy in the Royal College of Science, Dublin. Illustrated. Philadelphia: P. Blakiston, Son & Co. Pp. 336. Price, $6.

THIS work is especially designed for medical students, and for those who have a knowledge of the main facts of comparative anatomy and systematic zoölogy. There are eight chapters, dealing with maturation and fertilization of the ovum, segmentation and gastrulation, formation of the mesoblast, general formation of the body and development of the embryonic appendages, organs derived from the epiblast, hypoblast, and mesoblast, respectively, and closing with a chapter of general considerations. Certain structures and processes which are of secondary importance, or present especially difficult problems, have been briefly mentioned or omitted. Where hypotheses have been introduced, care has been taken that the student may not mistake them for facts. Important matter has been distinguished by large type, and most of the figures have been so drawn as to admit of distinctive coloring. The classification of genera adopted is embodied in an appendix. The volume is furnished also with an analytical table of contents, an index, and a bibliography.

THE CLAIM OF MORAL INSANITY IN ITS MEDICO-LEGAL ASPECTS. By JAMES HENDRIE LLOYD, M. D., Philadelphia. Pp. 16.

THE author, who has had a large experience with cases of insanity, has not seen one case which answers to the description given in the books, of moral insanity; that is, of pure and simple dislocation of the moral nature; but all cases were accompanied with perversions of the understanding. He believes, therefore, that the conception of "the cerebrum as an individual unit, whose special act is always a reflex process of ideation, tends to a satisfactory definition and classification of insanity, as well as to an intelligible application of our knowledge to the solution of medico-legal questions much superior to anything attainable by the distinctions of the metaphysicians or the arbitrary tests of the judges."

THE FORTUNES OF WORDS. Letters to a Lady. By FEDERICO GARLANDA, Ph. D. New York: A. Lovell & Co. Pp. 225. Price, $1.25.

THIS is a series of popular essays on English philology, which, together with much curious and useful information, conveys a vivid idea of the contrast between the modern method of scientific research in the department of language and the ways of the old etymologists. Separate chapters show how the development of industry, ethical feelings, the color-sense, and calculation may be traced in language. In another chapter the chief reasons why words change their meanings are given. The author does not utterly condemn slang, but points out that language gains some of its most vigorous expressions from the better class of slang.

HEALTH LESSONS. A Primary Book. By JEROME WALKER, M. D. Illustrated. New York: D. Appleton & Co. Pp. 194. Price, 56 cents.

No child can fail to be interested and instructed by this little book. The subject-matter is embodied in simple and vivid language, and is illustrated by an abundance of original and entertaining pictures. These

lessons deal almost entirely with hygiene, the author deeming it injudicious to require young children to learn much about the names and locations of bones and blood-vessels, etc. The book is divided into sixteen "lessons" of moderate length, each having at the end a short list of questions with answers. Following these is a chapter on "Accidents, Injuries, and Poisons." Some practical suggestions to teachers of health-subjects are prefixed to the volume. Special teaching as to the effects of alcoholic stimulants and of narcotics upon the human system is given in connection with the descriptions of the chief organs of the body.

LIGAMENTS, THEIR NATURE AND MORPHOLOGY. By JOHN BLAND SUTTON. Illustrated. Philadelphia: P. Blakiston, Son & Co. Pp. 107. Price, $1.25.

THIS treatise is designed to be a systematic account of ligaments and fasciæ generally, with respect to their morphology and ancestral history. Frequent reference has been made to the facts of comparative anatomy, but for the convenience of the student of human anatomy these facts have been concentrated in one chapter. The author finds that the more important ligaments "are derived either from the metamorphosis and regression of muscles, or the degeneration of osseous and cartilaginous tissues." The metamorphosis of contractile into fibrous tissue is caused by disuse and consequently diminished nutrition. In the case of many ligaments of the axial skeleton and pectoral girdle, bones corresponding to them in position have been found in certain of the lower animals, showing that these ligaments have arisen from a degeneration of osseous and cartilaginous tissues, during the development of the human species.

CHAUVENET'S TREATISE ON ELEMENTARY GEOMETRY. Revised and abridged by W. E. BYERLY, Professor of Mathematics in Harvard University. Philadelphia: J. B. Lippincott Company. Pp. 322. Price, $1.20.

PROFESSOR BYERLY'S edition of this standard text-book is carefully adapted to obtaining as much original work as possible from the student. He maintains that the student should be compelled to think and to reason for himself, thus gaining the power to grasp and prove any simple geometrical truth that may be set before him. "On this account, the demonstrations of the main propositions, which at first are full and complete, are gradually more and more condensed, until at last they are sometimes reduced to mere hints, by the aid of which the full proof is to be developed; and numerous additional theorems and problems are constantly given as exercises for practice in original work."

PUBLICATIONS RECEIVED.

Henderson, C. Hanford, Philadelphia. Glass-making. Pp. 26.

Holmes, Howard M., Lansing, Mich. Incineration of the Dead. Pp. 11.

Baker, Henry B., Lansing, Mich. Diagrams to illustrate a Paper on the Relations of Certain Meteorological Conditions to Diseases of the Lungs and Air-Passages. Fourteen Diagrams.

Canfield, William Buckingham, M. D., Baltimore. Cyclic Albuminuria. Pp. 8.

Beale, F. M. M., U. S. Signal Corps. "Monthly Weather Review," July, 1887. Pp. 20, with Charts.

Riley, Charles V., Department of Agriculture. Report of the Entomologist for 1886. Pp. 140, with Plates.

Bryce, James, M. P. The Predictions of Hamilton and De Tocqueville. Baltimore: Johns Hopkins University. Pp. 57. 25 cents.

Black, James. Report of the Commissioner of Pensions for 1887. Washington: Government Printing-Office. Pp. 95.

Williams, Dr. J. W. "The Naturalist's Monthly." Vol. I, No. 1, September, 1887. London: Walter Scott. Toronto: W. J. Sage & Co. Pp. 20. 6d.

Packard, A. S. On the Syncarida, on the Gampsonychidæ, and on the Anthracaridæ (new fossil crustaceans). Pp. 17, with Plates. On the Carboniferous Xiphosurous Fauna of North America. Pp. 13, with Plates.

Baskerville, W. M. An Outline of Anglo-Saxon Grammar, with a List of Irregular Verbs, by James A. Harrison. New York and Chicago: A. S. Barnes & Co. Pp. 66.

Jones, William H. Federal Taxes and State Expenses. New York: G. P. Putnam's Sons. Pp. 135. $1.

Parlor Games. Rochester, N. Y.: The O. M. Hubbard Company. Pp. 96. 50 cents.

Norman, Henry. Bodyke: A Chapter in the History of Irish Landlordism. New York: G. P. Putnam's Sons. Pp. 78. 75 cents.

Marks, William Dennis. The Relative Proportions of the Steam-Engine. Philadelphia: J. B. Lippincott Company. Pp 289. $3.

Cooper, Sarah. Animal Life in the Sea and on the Land. New York: Harper & Brothers. Pp. 413.

Love, Samuel G. Industrial Education. New York and Chicago: E. L. Kellogg & Co. Pp. 326. $1.75.

Annual Report of the Operations of the United States Life-Saving Service, 1885-'86. Washington: Government Printing-Office. Pp. 550.

Bulletin of the United States Fish Commission. Vol. VI, for 1886. Washington: Government Printing-Office. Pp. 495.

Three Good Giants. From Rabelais. Compiled by John Dimitry. Boston: Ticknor & Co. Pp. 246. $1.50.

Greene, William H. Wurtz's Elements of Modern Chemistry. Philadelphia: J. B. Lippincott Company. Pp. 770. $2.50.

Marks, William Dennis. Nystrom's Pocket-Book of Mechanics and Engineering. Philadelphia: J. B. Lippincott Company. Pp. 670. $3.50.

Knox, Thomas W. Decisive Battles since Waterloo. New York: G. P. Putnam's Sons. Pp. 417.

Ridgway, Robert. A Manual of North American Birds. Philadelphia: J. B. Lippincott Company. Pp. 630, with 124 Plates. $7.50.

Jackson, Edward P. A Manual of Astronomical Geography. Boston: D. C. Heath & Co. Pp. 73.

Munroe, Charles E. Notes on the Literature of Explosives. No. XIII. Pp. 24.

Land, Dr. C. H., Detroit, Mich. The Inconsistency of our Code of Dental Ethics. Pp. 32.

Lewis, T. H. Incised Bowlders in the Upper Minnesota Valley. Pp. 4.

Hay, O. P., Irvington, Ind. On the Manner of Deposit of the Glacial Drift. Pp. 8. The Red-Headed Woodpecker a Hoarder. Pp. 4.

Holmes, Mary E. The Morphology of the Carinæ upon the Septa of Rugose Corals. Boston: Bradlee Whidden. Pp. 31, with Sixteen Plates.

Everhart, Professor Edgar. Infant Food and Infant Feeding. Houston, Texas. Pp. 20.

POPULAR MISCELLANY.

Recent Advances in Sanitary Science.—According to a review of the subject in "Nature," the principal fields in which advance has been recently made in sanitary science are the etiology of such diseases as Asiatic cholera, typhoid fever, diphtheria, and tubercular disorders of the lungs. The organism observed by Koch may not yet have been proved to be the actual cause of cholera; but it has been shown to be different in its mode of growth from all other organisms asserted to be identical with it, and is therefore diagnostic of the disease. In any event, the validity of the measures relied upon to prevent cholera from breaking out and spreading is not affected by the results of Koch's researches. While no micro-organism has yet been found which can be asserted to be the peculiar origin of typhoid fever, the view that that disease arises from a specific contagion, and is not propagated *de novo*, is gaining ground; and we have learned so much regarding the mode of origin and spread of the disease, that the discovery of its active cause would probably not greatly affect the measures now taken for its prevention. No results that can be exactly formulated have been obtained respecting diphtheria. It is not invariably dependent on insanitary conditions, and some facts indicate that the presence in the air of products of coal-combustion is unfavorable to it. The character of the seasons when it is most prevalent favors the theory that its specific contagium is a mold or fungus, which flourishes most strongly in a damp and smokeless air. Koch's discovery of the *Bacillus tuberculosis* as the specific contagium of tubercular disease places that malady in the class of contagious disorders. The fact that milk has been found capable of conveying disease directly or indirectly suggests the prudence of boiling it whenever suspicion of danger exists. Advances in domestic sanitation have mostly been limited to applications of principles already ascertained, especially in the drainage and water-supply of dwellings. The belief is steadily gaining ground that water once polluted by sewage can not be regarded as safe for drinking. The introduction of constant supplies of water into towns has been of great benefit. The separation of rainfall from sewage is growing in favor. The purification and utilization of sewage are receiving increased attention. The present condition of knowledge on the subject demands that sewage should, wherever it is possible, be utilized on land, as manure, in the production of crops and dairy produce; failing in this, it should be freed from its solids by precipitation, and then purified on land laid out as filter-beds. In all cases, efficient purification, not the production of crops, should be the controlling object.

Chinese in America.—Professor Stewart Culin, in the American Association, described the characteristics of the Chinese immigrants in America. They all come from the departments of Kwang Chan and Shan-King, in the province of Kwantung. They describe themselves as "Puntis," or natives, as distinguished from the tribes called "Hal-Kus," or "Shangers," who seldom emigrate, and divide themselves into the people of the Sam-Yup (three towns) and those of Sz'-Yup (four towns), from terms applied to different divisions of their native province. The people of the different districts show distinguishing peculiarities of speech and customs. Representatives of some twenty or thirty clans only are found among the immigrants. The stores

are the centers around which life in the Chinese colonies revolves, furnishing supplies of Chinese wares, and serving as club-rooms and assembly-halls. Nearly all of the Chinese in America have passed some of their early years at school, where they learned to write some of the characters in their language, and to read it with more or less facility. Among the immigrants from Hoh-Shan and the districts adjacent to Canton are found many of considerable attainments—not men who would be considered scholars in China, but clerks, who are able to read and understand much of the classical literature of their country, and whose sympathies and traditions are allied with those of the literary aristocracy. This class forms a small part, however, of the whole number.

The Table-topped Hills of the Amazon.—To any one ascending the Amazon River, said Mr. James W. Wells, in the Royal Geographical Society, a most noticeable feature strikes his attention, in the table-topped hills of the Serras de Erere and Obidos, and the somewhat similar formation on the opposite bank, at the rear of the Santarem. These opposite islands form the walls of the valley through which the river, once probably a great inland lake, has excavated its way to the sea. Their summits, instead of being ridges, extend in the form of undulating savannas far inland, ever ascending, furrowed with hollows and valleys by many a stream or water-course. Strange and interesting as is the appearance of these cliffs of one thousand feet in height, yet they are not exceptional features of the basin of the Amazons; at its farther western extremity, in the Serra de Cupati, bordering on the banks of the Rio Japura, and also on the western face of the Chapada da Mangabeira, are encountered identical formations, and even to the north in Roraima and its brother Kukenam, also exists a somewhat similar appearance. These great, precipitous bluffs, and isolated table-topped hills are indicative, or at least suggestive, of a great denudation that has either long since occurred, or is yet happening. The Chapada da Mangabeira rises gradually and by regular gradients from the San Francisco River to the divide, where it appears as perpendicular walls of sandstone, with flat summits, and looks, when viewed from the east, like gigantic fortresses. The base of these cliffs is composed of a natural earth-slope of the modern *débris* of the fallen materials of the walls. Evidence is presented that this table-land extended yet farther to the west from twenty to sixty miles. The vegetation and soil of the tops of these miniature Roraimas are precisely similar to those of the great plateau, whereas the vegetation of the surrounding lowlands is quite different in character.

Some Notes about Bees.—A recently published book by Mr. Frank R. Cheshire, lecturer at South Kensington, gives some curious items of information about bees. A lens magnifying fifty times will reveal the tracheæ, and also the beautiful "salivary glands," which a skillful operator may extract through the head, after immersing the insect up to its neck in wax." There is considerable discussion among apiarists as to the uses of these glands, in which is incidentally included the question whether bees feed their young by regurgitating semi-digested food, or by a glandular system producing a nutritive secretion. Mr. Cheshire finds in the digestive system, in which "the salivary and gastric secretions perform precisely the same functions in both," ... a most helpful similarity of physical structure between mankind and bees." Bees have, however, the great advantage over mankind of being able to carry a large stock of food and drink in their insides, and of having the power of feeding upon these stores by means of what is called the "stomach-mouth," at pleasure; or, if they choose, they can convert these provisions into building-materials. Their foot is furnished with a very sharp and powerful claw, and with a sort of soft pad that gives out a clammy secretion, by means of which they are able to walk on smooth surfaces. It is by the claws that bees hang one to another in swarming. The cutting off of a bee's head does not apparently of necessity kill it; for "drones in confinement will sometimes live very much longer without their heads than with them." The head, however, is not an unimportant part of the bee, which has a larger proportion of brain than many other insects. The

poisonous property of the sting of bees lies in the formic acid it discharges, which is also "probably associated with some other toxic agent." The idea that the bee invariably dies after stinging is a vulgar error. "It will, if allowed time, generally carry its sting away by traveling round upon the wound, giving the instrument a screw-movement until it is free." More usually, however, the bee is not allowed time to travel round, "and she loses not only the sting and the venom-gland and sac, but also the lower portion of the bowel, so that her death follows in an hour or two." We are further informed that no bee inflicts a wound "until she has examined the nature of the surface to be punctured, using a pair of very beautiful organs called palpi, elaborately provided with feeling hairs and thin nerve-ends."

Mr. Edison's Pyromagnetic Dynamo.—Mr. Edison, in his paper, at the American Association, on the "Pyromagnetic Dynamo," after describing the construction and operation of the machine, said that the results thus far obtained lead to the conclusion that the economy of production of electric energy from fuel by the pyromagnetic dynamo will be at least equal to, and probably greater than, that of any of the methods in present use. But the actual output of the dynamo will be less than that of an ordinary dynamo of the same weight. To furnish thirty sixteen-candle lights in a dwelling-house would probably require a pyromagnetic generator weighing two or three tons. Since, however, the new dynamo will not interfere with using the excess of energy of the coal for warming the house itself, and, since there is no attendance needed to keep it running, there would seem to be already a large field of usefulness for it. Moreover, by using the regenerative principle in connection with it, great improvement may be made in its capacity, and its practical utility may very probably equal the interesting scientific principle which it embodies.

Characteristics of Tropical Woods.—Professor R. H. Thurston, describing some Nicaraguan woods in the American Association, said that the tropical and sub-tropical woods are distinguished usually by their extraordinary size, strength, hardness, and solidity, as well as by durability, as against both weather and the attacks of insects. About thirty samples, selected simply by considerations of convenience and previous acquaintance from among an enormous number of probably equally valuable genera, were subjected by the author to special tests. Some of them resembled in appearance and quality mahogany; some, our own yellow pine; others, the oaks and other hard woods of our forests, but excelled them in density, strength, elasticity, and durability. While they may prove of extraordinary value for many purposes, they are often so hard to work that their usefulness is likely to be restricted. The Central American forests contain an enormous store of timber of remarkably fine quality.

Exceptions to the Rule of Laissez-Faire.—Professor Sidgwick read an elaborate paper in the British Association on the economic exceptions to the *laissez-faire*. Political economy, he said, as commonly understood, includes a general argument showing how wealth tends to be produced most amply and economically in a society in which government confines itself to the protection of person and property and the enforcement of contracts not brought about by force or fraud, leaving individuals free to produce and transfer to others whatever utilities they choose on any terms that may be freely arranged. The argument is, briefly, that in a society so constituted, the regard for self-interest on the part of consumers will lead to the effectual demand of the things that are most useful, and the regard for self-interest on the part of producers will lead to their production at the least cost. It is, however, now generally held that the broad rule of "leave alone," to which the argument points, must in practice be limited by various exceptions. Two classes of these exceptions are distinguished, viz.: (*a*) those which are due to the limitations under which abstract economic theory has to be applied in the art of government; and (*b*) those which it is the more direct business of economic theory to analyze and systematize. In class (*a*) may be distinguished—(1) governmental interference to regulate the education or employment of children; (2) interference for the promo-

tion of morality, health, and culture; (3) interference, not with a view to the economic production of wealth, but with a view to its more equitable distribution (this is often spoken of as "socialistic" or "semi-socialistic"); (4) interference on the ground that certain industrial classes are found by experience not to take sufficient care of their private economic interests (this is sometimes spoken of as "paternal legislation"), e. g., restrictions on freedom of contract between landlord and tenant. The same phrase is also applied to (2). As leading cases of class (*b*) may be noted—(1) where for the production of a certain utility or avoidance of detriment, a combination is required of which the value largely depends on its universality—e. g., protection of lands against floods, protection of useful animals against certain diseases; (2) especially where the combination of a large majority increases the interest which the minority have in standing aloof—e. g., abstinence from certain times, places, or instruments in fishing or hunting for the sake of future supply; (3) where a branch of industry, for technical or other reasons, has a tendency to fall under the conditions of monopoly, total or partial—e. g., provision of gas in towns; (4) where, from the nature of the required utility, its producers could not be remunerated adequately in the ordinary way by free exchange of their commodity—e. g., utility of forests in relation to climate or scientific discoveries; (5) where the process of exchange which would be required to remunerate a certain social service, would seriously detract from its utility, from waste of time or otherwise—e. g., provision of roads and bridges; (6) where government is peculiarly adapted to produce the kind of utility required—e. g., if what is required is security, as in the case of savings-banks, or uniformity, or stability of value, as in the case of currency. It is not argued that government necessarily ought to interfere in all cases that come under these headings; only that the general economic argument for *laissez-faire* falls away in such cases, wholly or to a great extent, or is balanced by strictly economic considerations on the other side; and that it is important to bear this in mind in discussing any particular practical case.

The Luminous Organs of an Insect.—Dr. Dubois has investigated the light-emitting organs of the *cucuyo*, or *Pyrophorus noctilucus*. They are three in number—two prothoracic and one ventral. The prothoracic plates give a good illumination in front, laterally, and above, and serve when the insect walks in the dark; when it flies or swims, its fine abdominal lantern is unmasked, throwing downward an intense light with much greater range. The insect seems to be guided by its own light. If the prothoracic apparatus is quenched on one side with a little black wax, the cucuyo walks in a curve, turning toward the side of the light. If both sides are quenched, it walks hesitatingly and irregularly, feeling the ground with its antennæ, and soon stops. The light gives a pretty long spectrum from the red to the first blue rays; is more green than the light of *Lampyris noctiluca*, and is capable of photography, but does not develop chlorophyl. No distinct electric action could be traced to the organs. The luminosity does not depend upon oxygen, for it is the same in pure oxygen, in air, in pressures under one atmosphere, and in compound oxygen. The organs are still brilliant when separated from the body, but the power of emission appears to depend upon a supply of water, and it is recoverable, after thorough drying, upon putting the organs again in water. Dr. Dubois found that the photogenic substance is an albuminoid, soluble in water and coagulable with heat, it entering into contact with another substance of the diastase group; part of the energy liberated appears as light.

The Drying up of Siberian Lakes.—Mr. Yadrintseff has furnished the St. Petersburg Geographical Society with evidence, consisting of notes of surveys, and maps made at four different periods, that the lakes in the Aral-Caspian depression have dried up within the last hundred years "at a speed which will surely appear astonishing to geographers." Lake Chany, the largest of the three principal lakes, has much diminished in size. Whole villages have grown on the site formerly occupied by Lake Moloki. Of Lake Abyshkan, which had a length of forty miles from north to south, and a width of seventeen miles, in

the earlier years of this century, and whose surface was estimated at five hundred and thirty square miles, only three small ponds have remained. Even twenty-five years ago there were several lakes, ten and eight miles long and wide, where there are now but little ponds. The fate of Lake Abyshkan is substantially repeated in Lake Chebakly, which was represented in 1784 as an oval body forty miles long and three miles wide. Now, the largest of the three ponds which occupy its site is less than two miles wide. The same process is going on throughout the lakes of West Siberia and throughout the Aral-Caspian depression.

Electric Deposition of Dust.—Professor Tyndall observed, in 1870, that when a hot body was held in strongly-illuminated, dusty air, a dust-free space was formed above it, and this may take place even when the body is only slightly warmer than the air. Several hypothetical explanations of the phenomenon have been offered by Dr. Tyndall, Dr. Frankland, and Lord Rayleigh, but they have been inadequate to meet the requirements of the case. Professor Oliver Lodge has sought an explanation by the application of the kinetic theory of gases, and supposes that the dust-particles are kept out of contact with the warm body by means of a differential molecular bombardment of their surfaces. On the other hand, with the singular and not explained exception, that a similar dark plane, but descending, is formed below a moderately cool body, the dust-particles are driven toward, instead of away from, a cold body. This fact has been observed by Mr. Aitken, and applied by himself to the explanation of the deposition of soot in chimneys, and of lamp-black on cold glass. The result of the dust-bombardment of cold bodies may also be seen in the blackening of a wall over hot-water pipes, or of a ceiling over a gas-jet. Smoking of the gas-jet will, of course, provide more material to be deposited, but the dust and smoke in the air are usually ample to effect a sufficient blackening over even a perfectly clear flame. An incandescent electric lamp, hung a foot or so under a white ceiling, will similarly cause a small, black patch. In rooms warmed by radiation, objects are warmer than the air, and keep much dust off themselves. In stove-heated rooms, things are liable to be colder than the air, and thus get exceedingly dusty. Professor Lodge supposes, also, that electrical conditions may have much to do with the matter, and relates several experiments which he has made that go to confirm this view. One of them is made with a minute, vertical water-jet, which usually scatters into drops and falls in a shower-like rain; but hold a piece of rubbed sealing-wax a yard or so distant from the place where the jet breaks, and the drops at once cease to scatter, but fall in large blobs, as in a thunder-shower. These principles are susceptible of application in many processes where dust is generated in quantities that make it a nuisance for laying it. Thus, chimney-flues may be fitted with spikes or wire nettings, which will cause the smoke to be condensed, and the dust to be deposited. So, on a larger scale, the introduction of electrical action into a cloud is supposed to give rise to rain.

Origin of Strong Liquors.—Strong liquors are a modern invention. The ancients knew of nothing more powerful than lightly fermented wines, and have left warnings enough of the abuse of them. Alcohol was not discovered till the seventh century, although an older story exists of a monk, Marcus, who collected and condensed in wool the steam of heated white-wine, and then pressed out from the wool a balsam which he applied to the wounds of those who fell at the siege of Rheims, in the reign of Clovis I. He also mixed this balsam with honey, and produced a cordial which brought the moribund back to life. Clovis, however, did not wait for the approach of death, before claiming his share of the cordial. According to Dr. Stanford Chaille, the distillation of spirits from wine was not discovered till the twelfth century, and spirits did not come into common use as drinks until the fifteenth, sixteenth, and seventeenth centuries. Professor Arnoldus de Villanova, in the fourteenth century, made a panacea of the water-of-life, which gave sweet breath, and fortified the memory, besides being good for sore eyes, the toothache, and the gout, and having other

wonderful properties. Distilled spirits came into use in London in 1450, and had to be prohibited in 1494. Michael Savonarola produced a treatise on making the water-of-life in the fifteenth century, which became a standard authority on the subject, and was followed by the work of Matthioli de Sienna. These books gave the start to brandy-making in Italy, whence the trade extended to France. About 1520 the Irish usquebaugh began to acquire reputation in England. Before 1601, "brand-wine" had begun to be distilled in the Low Countries from apples, pears, and malt; and in that year an ordinance was passed at Tournay forbidding the sale of the liquor except by apothecaries, partly "because of the dearness of corn, and partly because of the drunkenness which this cheap brand-wine caused, to the great prejudice not alone of homes and lives, but to the extreme danger of the souls of its drinkers, many of whom had died without confession." The art of extracting alcohol from other substances, was gradually discovered, and liquors of various names came into use. The trade grew great, and the present century has seen a new development of it in the general application of the art of "doctoring" liquors, or adulterating.

Are there Catastrophes?—Read Mr. J. H. Kerry-Nichols's account of one only of the many things that took place in New Zealand on a June day only about a year ago: "The most remarkable feature in the same line of volcanic action was the extraordinary convulsion which had changed the whole conformation of the country around Rotomahana, and had transformed the hot, green lake with its marvelous terraces into a roaring crater, from which rose a column of steam nearly a mile and a quarter in diameter, that ascended in the form of a cumulus cloud to a height of thirteen thousand feet, and nearly a mile in width. Thus in the brief space of four hours this delightful fairy-land was transformed into a condition suggestive of a scene in Dante's 'Inferno.' The spot where the white terrace formerly stood had been occupied by a crater, forming a kind of horseshoe bay, and from this a column of steam rose and mingled with the general mass. The site of the Pink Terrace, once on the western shore of the lake, now stood a quarter of a mile from the margin of the present crater, in the midst of a mass of boiling mud black and brown in color, with seething pools of steaming water or liquid mud, which was sometimes cast up into fumaroles, ejecting steam and vomiting forth stones and mud, with a noise like the roar of innumerable steam-engines."

Persian Astrologers.—The *monajem*, or astrologer, is a power in Persia. He is recognized as a man of science, a member of a learned profession. The chief astrologer is a high court official, from whose ruling there is no appeal, for his decisions are based upon knowledge that is communicated directly from the stars. Thus, if he decrees that the Asylum of the Universe must not start on a hunting expedition on Thursday, but that half an hour after midnight on Saturday will be the fortunate hour, he is able to give irrefragable reasons for his conclusions by showing that Saturn is in the ascendant in the one case, while on Saturday night, at the precise time mentioned, there will be a happy conjunction of Venus. If another astrologer is consulted, he will give the same story. Every hour in the day, and every day in the year, is thus worked out as fortunate, indifferent, or unlucky in the astrologer's Books of Fate. Besides these calendars, they have as their stock in trade a plumb-line, a level, a celestial sphere, and an astrolabe. The astrolabes are in the form of a gigantic watch, and are often beautifully made. Every large town contains at least two astrologers, and they are very far from being poor. A Persian may find an astrologer very useful, especially if he be an officer, and desire to evade some responsibility. Thus, suppose a provincial governor is ordered to the capital, and that he does not want to go, what more powerful reason for delay in starting than to reply that he is waiting for a fortunate hour, and what easier than to induce the astrologer to fail to find one? In the mean time, the officer has time to administer the necessary bribes at court, and the storm blows over. *Istikhara*, tossing up, or the drawing of the lot, is done with a rosary. A bead is grasped at hap-hazard, "Good," "Bad,"

"Indifferent," is ejaculated at each bead, till the big terminal one is reached, and that decides the question. Answers are given in conversation, bargains are made or refused, and serious acts are undertaken under the guidance of this formula. Another way is to thrust a knife into the leaves of the Koran or one of the poetical books, and be guided by what is found at the place. The diviners are real quacks, and gain their success by working on the fears of the people. The guilty party in a scandal or criminal inquiry in his nervousness is provoked to do some act that brings about his detection.

The Nature of Diatoms.—The curiously beautiful microscopic objects called diatoms can be found in the mud at the bottom of all pools of water. They were formerly regarded as animals, but are now classed among plants. Professor W. Mattieu Williams discovered their vegetable character thirty years ago by an observation which amounted to a demonstration. The white quartz pebbles in his aquarium became coated with a brown growth, caused by the development of these organisms, and at the same time evolved bubbles of gas. In the course of a few days he found an inch of the vertical space of the test-tube which he fixed to catch it filled with this gas, and it was proved by burning wood and other experiments to be nearly all oxygen. Animals expire carbonic acid, plants expire oxygen. Therefore the diatoms were plants.

A Rock-sculptured City.—Montpellier-le Vieux is the name given to a curious city-like group of weather-sculptured rocks, which M. E. A. Martel has described to the French Academy of Sciences. It is near Millau, in Auvergne, France, and about twenty-five hundred feet above the sea. It is composed of a mass of isolated rocks, averaging perhaps about two hundred feet in height, so similar to embattled towers that one group has been called the Citadel; around this mass are five depressions three or four hundred feet deep, of which one resembles an amphitheatre, a second a necropolis, a third a parade-ground, and another a regularly laid out city quarter with public monuments, gates, straight streets and intersections suggesting at once such places as Pompeii, Carnac, and Persepolis. The whole, occupying about five hundred acres, is surrounded by a rocky formation having the aspect of a wall three or four hundred feet high. The ravines under the bases of these walls might be regarded as fosses, and the scattered groups of rocks in the neighborhood as the fortifications of outer lines of defense.

Idiosyncrasies of Plants.—An English reviewer of a book by Mr. Charles Roberts, called "The Naturalist's Diary," mentions the idiosyncrasies of certain plants and animals as a feature to which more attention might be given. Thus, a quantity of seed taken from the same plant at the same time, and sown under the same conditions so far as possible, will nevertheless exhibit very great variation in the length of time required for germination. The fact enforces the circumstance that the same amount of aggregate temperature and of water-supply, the same conditions of soil, etc., do not necessarily imply corresponding identity of result. The same thing happens in trees. Every one knows how some individual horse-chestnut trees are year by year more precocious in their development than their fellows. It sometimes happens, too, that one branch of one tree is considerably in advance of the others. Some persons might call these cases exceptions, but they are hardly that. Since they are connected with the main body of habitudes by every possible gradation, they are to be considered as extremes rather than as exceptions, and therefore to be included in the making up of averages.

NOTES.

PRESIDENT PECKHAM, of the Natural History Society of Wisconsin, has been investigating the mental habits and peculiarities of wasps. On the question whether these insects have much sympathy with one another, he says: "To be sure, when we caught numbers of them, and painted them within the cage, they at once went to work to clean each other, and this shows that they have some desire to aid and comfort their friends. But we have often seen them continue to eat, with entire composure, near the body of one of their number that had just been crushed to death; and they frequently fall upon a dead relative, cut it up, and carry it into the nest to feed their young."

MR. H. STUART WORTLEY, of the South Kensington Museum, has been led, by long and careful attention given to the observation of animals, to consider that they have true reasoning powers, and says on this subject: "I have frequently seen reasoning power exercised after obvious thought over the best course to pursue. Then, *are* animals speechless among themselves? I think not, and believe they speak freely to one another at needed times, in their own language. And I certainly with my own domestic animals can understand in a certain sense their language. I clearly know what they ask for, or what they wish to call my attention to, from the tone of the voice and its modulations, and this is, I assume, language as regards them."

PROFESSOR HELMHOLTZ has been appointed President of the *Kuratorium* of the Physical and Technical Imperial Institution which is to be opened at Berlin in 1888. Dr. Werner Siemens, the founder of the Institution, and Dr. Förster, the Director of the Berlin Observatory, will also be curators.

ACCORDING to Mr. John Ball's "Notes of a Naturalist in South America," the various ports along the arid coast of Peru, destitute of verdure, reveal upon close examination the presence of plant-life. At Coquimbo veritable bushes and a greenish-gray tint on the surface of the soil were visible, and specimens were obtained of some curious and rare plants in flower peculiar to the vicinity, among them a dwarf cactus only three or four inches in height, with comparatively large crimson flowers.

AN appearance as of being hollowed out has been remarked in the surface of the hard, green sandstone rocks, near Lima, Peru, and was ascribed by Sir Charles Lyell to the result of water-action on ancient and subsequently elevated sea-beaches. Mr. Nation, of Lima, however, who has been observing the rocks for twenty-five years, is satisfied that the hollows are increasing in size and in number. He believes that they are the work of a cryptogamic plant, a lichen, which is in active vegetation during the foggy season, the swelling of whose cells causes a scaling of the rock.

A NEW telephonic apparatus, called the "Micro-telephone Push-button," has been successfully experimented with in Paris. It has the form of an ordinary electric push-button, and is so sensitive that in speaking at short distances there is no need to come close to the instrument. Persons using it may speak in their ordinary tone, walk about, and act as if they were conversing with some person in the room. The paragraph from which we derive this item intimates that the perfection of the instrument is due to the inventor having resided in America, where his inventive talent was stimulated.

MR. CLEMENT REED, of Oneglia, believes that the destructive effects of the earthquake in the Riviera may have been more owing to the method of building than to the violence of the shocks. The walls of the houses at Oneglia and at Diano Marina are built of rounded stones or rubble, filled in with stucco, and the floors with brick arches, without sufficient care being given to lateral support; and the houses are usually three or four stories high. It is evident that even a slight shaking would be fatal to buildings thus constructed.

MR. CHAMBERLAIN, in his monograph on the Ainos, asserts, on the authority of the Rev. Mr. Batcheler, who has lived among that people for many years, that intermarriages between them and the Japanese are not fruitful, and conduce to weakly offspring and a short-lived stock. There seems, therefore, to be a kind of reproductive incompatibility between the two races. The occupation of the northern islands by the Japanese in place of the Ainos, who are diminishing, or of a half-breed race which is not found, may be accounted for by the unfruitfulness of the half-breeds, and by the superior vigor of the Japanese race to the Ainos.

MRS. HARDWICKE, widow of the founder of "Science Gossip," preserves eggs fresh by carefully oiling them with a soft brush all over, and packing them in a jar with plenty of bran between each layer. A thick brown paper should be tied over the jar when it is full. "When eaten at three months old," she says, "you could not tell them from fresh eggs."

THE announcement is provocative of thought that the invitation which the Government of New South Wales gave last year to the British Association to meet in Sydney in January, 1888, has had to be withdrawn, because the matter had been made a party question in the New South Wales Parliament. The fact illustrates anew the truth that science and current politics will not mix.

ACCORDING to the observations of M. Cazeneuve, the aniline dyes—fuchsine, Bordeaux red, red, purple-red, etc.—employed in coloring wines, may persist for many years in certain wines, and be obtained intact therefrom by analysis. The chemical changes that wine undergoes, especially in the "stripping" of new wines, lead to the precipitation of a greater or less amount of the artificial coloring agent. The diseases produced by microphytes also cause a disappearance of color.

"SINCE the introduction of the water-closet, and, I believe, as a direct consequence of it," said Dr. G. V. Poore, at the anniversary meeting of the Sanitary Institute of Great Britain, "we have had four severe epidemics of cholera (a disease not previously known), and enteric or typhoid fever (previously almost or quite unrecognized) has risen to the place of first importance among fevers in this country (England). The evils which have arisen from cesspools and sewers have caused an enormous amount of attention to be devoted to what are known as 'sanitary appliances,' 'sewer constructions,' etc., and so great and so well recognized are the evils of sewers that many of our friends are anxious that we should be compelled by act of Parliament to protect ourselves from the mischief which previous acts of Parliament have produced."

THE preliminary steps have been taken for the organization of an Australasian Association for the Advancement of Science on the same lines as the British Association. The first and inaugural meeting is to be held in Sydney in 1888, which will be the centennial year of the foundation of the colony of New South Wales. The Royal Society of New South Wales, already in operation, is pursuing a system of offering medals and money prizes for original researches on scientific subjects, particularly for investigations relating to Australia. Four prizes are offered every year, consisting of the society's medal and £25, to be awarded for as many researches of superior merit.

A GRASS resembling the Canadian "sweet grass," but of finer texture and fragrance has been discovered growing at Ocean Beach, New Jersey, and is utilized by a family of Indians there for making fancy baskets. It is identified by Dr. Samuel Lockwood with the *Hierochloa borealis*, or "holy grass" of Europe, and as probably the same colony which Dr. Knieskern announced several years ago that he had discovered near Squan Village. As the name "holy" or "sacred" grass would be without significance in this country, and the fragrance of the plant is like that of vanilla, Dr. Lockwood suggests that it be called "vanilla-grass."

DR. J. W. STICKLER, in the "Report of the New Jersey State Board of Health," finds that persons who work in hat-factories are subject to lung-complaints arising from the inhalation of fur-dust. Silk-weaving in dwelling-houses is deleterious, but ought to be a healthy occupation in properly lighted, heated, and ventilated factories. The hackling of flax and jute fills the air with a dust of dirt and minute fibers, leading to paroxysms of coughing, and often to early death; and the spinning process is attended with similar evils. According to Dr. J. P. Davis, the disorders arising from India-rubber manufacturing are chiefly due to the lead-compounds used in the work, accompanied with heat and defective ventilation, to the introduction of naphtha, and to mechanical conditions.

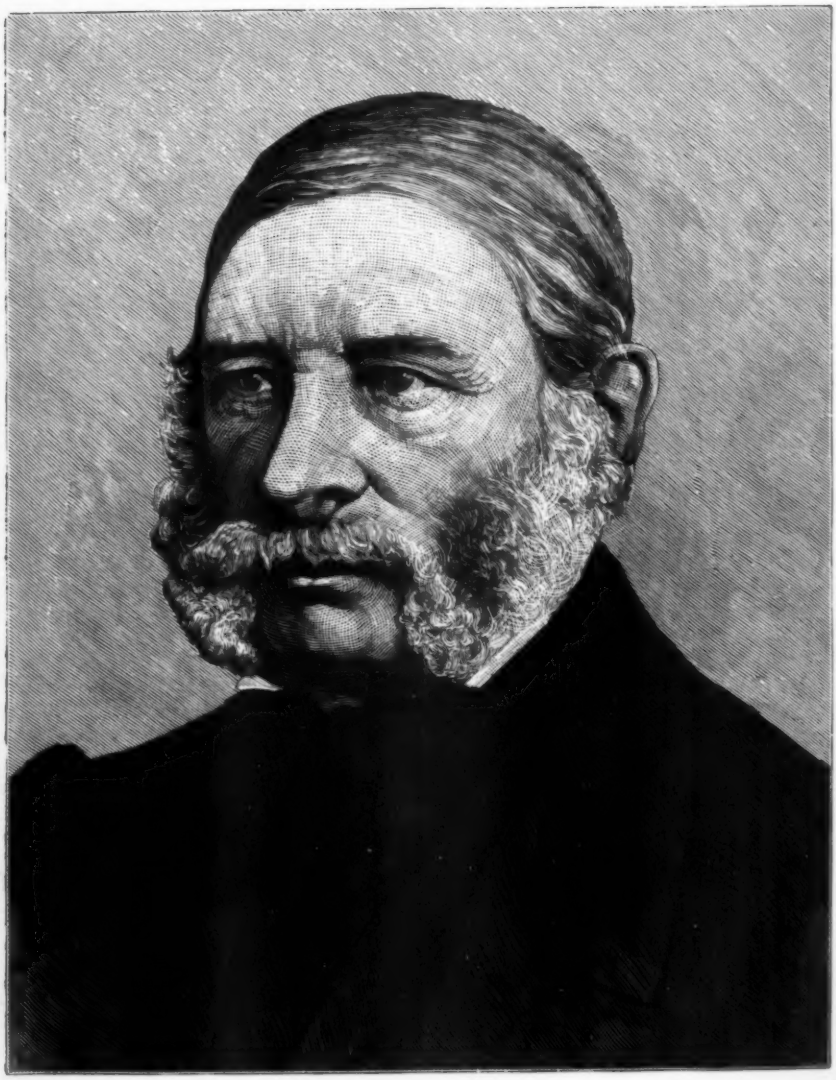
BISCUITS appear to have been the most ancient form of bread. It is not known how early fermentation was introduced, but it appears certain that cakes made simply of flour and water preceded it. Such cakes, of the Neolithic age, are found in the lake-beds of Switzerland—and these are the oldest surviving specimens of bread. Most of the ancient peoples used biscuits on special occasions, as of war and long voyages. The Greeks called them *arton dipuron*, or bread exposed twice to the fire. The Romans had their *panis nauticus* or *capta*. Our word *biscuit—bis*, twice, and *coctus*, French *cuit*, cooked, twice cooked, the same in meaning as the Greek name, is a survival from the original method of preparing the cakes, which is no longer in use.

PROFESSOR EMIL DU BOIS-REYMOND, the twentieth anniversary of whose appointment as Secretary of the Academy of Sciences of Berlin is celebrated this year, has had the privilege of introducing a succession of famous representatives of science in speeches which gave proof of his great ability as an author. He is one of the oldest members of the physico-mathematical class of the Academy; the only member of older standing being Chevreul, whose patent antedates his seventeen years.

THE city of Nancy, in France, on the 21st of July, suffered the strange visitation of a rain of wood-ants. It was about five o'clock in the afternoon when the "shower" came up, and the insects, both winged and unwinged, fell upon the streets and public places, and on the heads of passers-by, like a snow-squall, for about an hour. Most of the town was literally covered with ants. They are supposed to have been taken up somewhere and brought to the place by the strong gusts which preceded a severe storm that fell upon the city during the night.

PROFESSOR TYNDALL expressed a doubt, in his last Royal Institution lecture, as to whether extensive reading and study had not a tendency to hamper original genius; whether doctrines handed down for generations as articles of faith, which it would be heresy to dispute, had not materially checked the progress of science.

PILOCARPINE is an alkaloid obtained from the leaves of *Pilocarpus primatus*. It is a viscous substance, giving finely-crystallized salts, and has been applied to various therapeutic uses.



JOHN JACOB BAEYER.